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THE AMERICAN GAS-LIGHT JOURNAL AND CHEMICAL REPERTORY

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☞ An asterisk (*) denotes an illustrated article

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WISHING TO MAKE THIS JOURNAL an organ of intelligent discussion to those of our readers who may wish to gain or give information on the subjects to which its columns are devoted, the publishers solicit letters from all among them who make the study of these subjects a pleasure, or a profession.

Subscribers would confer a favor upon us by remitting *CHECKS*, or *POST OFFICE MONEY ORDERS*, as we are frequent losers where money is enclosed in letters.

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VOLUME XXIII.

With the present number we begin a new year of the JOURNAL. If we turn back to the files of the earliest issue of the paper, we find that its infancy was like that of men small in size but healthy and strong. The increasing demands of the people interested in gas making for more and fuller information have been met by increase of size in the JOURNAL, from time to time.

In 1859 there were about 400 companies in the United States; now the number is rapidly approaching 1,000. Great strides have been made in all the departments of the service. Results that then were thought impossible are now easily obtained; quality and quantity have both increased. To meet the progressive demands of the times the proprietors have again enlarged the number of columns of the AMERICAN GAS-LIGHT JOURNAL. We trust that while we increase our "yield" we may not at the same time reduce our "illuminating power," and that our readers will find that our additional columns are filled with material that may prove both instructive and interesting. There is one thing that we are very anxious to enlarge, and that is the space devoted to correspondence—we mean by this, correspondence upon the subjects daily coming up in the actual experience of gas men, and we most earnestly urge the fraternity to lend their aid in making this department of the JOURNAL more full. With this issue we change the arrangement of the paper so to make it more convenient for reference. The editorials will commence hereafter on the first page and will be preceded by an index, which will be made full, so that the contents will give at a glance a general idea of what each paper contains. Trusting that these efforts on the part of the proprietors and editor will meet with due consideration from our patrons and that no effort will be spared by any to increase the circulation and the usefulness of the paper; it shall be our endeavor to make the JOURNAL at all times reliable and as interesting as possible.

Subscriptions for the ensuing year are now due, and thanking those of our patrons who have already forwarded their dues, we would gently and courteously remind those who are in arears that money is a very necessary element in our business, and the receipt of it will be very gratefully acknowledged.

If any of our readers can send us additional names to be placed upon our subscription list, or new advertisements for our columns, they will practically aid the JOURNAL.

THE EXPLOSION IN SOUTH BOSTON.

The daily papers of last week gave accounts of an explosion in South Boston, the cause of which up to the present writing is not altogether clear. From the account given in the New York *Herald* of December 23rd, we take the following: "The main pipe, about five (?) inches in diameter, passes under Federal street bridge and along the causeway leading from it up Dorchester avenue (the continuation in South Boston of Federal street, Boston). This causeway is composed of three feet or more of dirt and gravel with the pavement, resting on a foundation of piling, and on either side for seventeen feet or more is the river. Eye witnesses state that the first intimation of the explosion was a bright flash about the middle of the causeway followed by a sharp explosion, and almost immediately after, the causeway on the right hand side, under which ran the gas main, fell over into the river, * * * The pavement was completely torn up for a distance of 175 feet from the wooden portion of the bridge to Crosby's warehouse, which is built upon piling at the end of the causeway on the South Boston side." * * *

The coroner's jury are to investigate the facts and no doubt will be able to get at a great deal of information on the matter which may be more or less useful; but *just how* it happened perhaps no one living can tell. But gas men are well aware that there is a certain admixture of gas and air, which upon being lighted is very powerful and destructive in its effects. A mixture of

One part of common gas and	6	parts	of air	explodes	feebly.
"	"	"	7 or 8	"	powerfully.
"	"	"	14	"	feebly.

A greater proportion of air than 14 parts to 1 of gas will not explode, but a taper will burn in the mixture with an enlarged flame.

From the description given above of the locality, the accident may have occurred as follows: The frost may have broken a pipe or caused a leak, the gas issuing from it may have distributed itself among the gravel, &c., between the pavement and the pile work until the proportions of 1 of gas to 7 or 8 of air had been reached when a spark or fire from some source may have ignited and exploded the mixture. The loss of life attending the accident is the most deplorable part of it. But many people are unaware of the dangers which attend the manufacture of gas. From all that has yet been learned of this case it would seem that it was not the direct result of neglect on the part of any one but one of those unfor

New York A. M. Callender 1877

seen combinations of circumstances that no one can predict. Such cases have occurred before in this city and elsewhere, but without such disastrous results. Upon one occasion in New York, a settlement, resulting from the building of a sewer, caused a breakage or leak in the neighboring gas main; the gas found its way through the loose material of the filling into the sewer. In some way the explosive mixture was ignited and a "blow up" followed, the man-hole covers of the sewer being thrown on the tops of adjoining houses, paving-stones and bricks flew in all directions. On a smaller scale similar cases are well known to gas engineers.

By statements made in some of the Boston papers, it would appear that there was a service pipe only laid under the causeway in South Boston, and that this had connections leading to the street-lamps, which were lighted at the time. This service pipe, said to be 2 inch, was securely packed in a box and examined from time to time, which indicate that due deligence was exercised. Yet the rapid corrosion of wrought iron pipes, especially when exposed to the action of a salt atmosphere is well known, and the many troubles arising from its use may have found one of the most terrible examples in this case.

The proper method of laying pipe in those parts of cities adjacent to docks, &c., has been a study for many years, and if this catastrophy, sad as it is in other aspects, shall be the means of establishing any points bearing on this branch of the gas engineer's business, it will not be without its benfits in the way of warning for the future which no prudent man could neglect. We trust that we shall be able to give our readers a full and clear account of the facts in our next and that those interested will spare no effort to determine the cause, and having done so that they will give the gas world the benefit of it. And in this connection it may not be amiss to state that we are anxious in all such cases to make simply a true record of facts, and we trust that those having knowledge of matters of like nature will not hesitate to send us the fullest reliable information that it may go on record correctly. We should never be ashamed or afraid to own up to mistakes. As a general rule a man who "never makes a mistake" never learns anything. Not that we advocate blundering by any means, but if, after ordinary precaution, accidents occur, we may naturally infer that we have been mistaken in some respects, and due investigation will show wherein. It is in this view that mistakes or failures to arrive at correct results are of benefit. This constitutes a large part of what we call experience, and hence its value. Careful men profit by the mistakes or experience of others, hence our desire to be able to impart the experience of one to others.

WATER GAS.

We give our readers to-day a carefully compiled synopsis of the efforts that have been made to produce illuminating gas from hydrogen, which is taken from the *Chemical News*, of London. In giving the article we have been careful to preserve all the foot notes and references, so that anyone who desires to investigate further can know where to look for fuller information on the points touched upon. No reference is made to the most recent attempts by the Gwynne Harris and the Lowe's processes to accomplish the same ends, but perhaps a careful study of past efforts may be of value in enabling those interested in forming a conclusion as to the probability of the success of these. They are both now in actual operation and time will demonstrate whether they are to take their places in the front rank of the great army of gas makers. We have been furnished with some figures as to the working of these two processes for the month of October, and we give them to our readers and each may make his own figures and calculations, and draw his own conclusions.

In addition to these, we are told that works are being fitted up for the manufacture of "water-gas," at Forty-first street and North River, which, it is expected, will soon be "in blast" and ready to supply consumers.

Workings at Poughkeepsie for October, 1875.

Gas made	1,317,100 cubic feet.
Average candle power	17.23 candles.
Specific Gravity of Gas	.740

Used in Retorts.

Anthracite Coal	21,127 lbs.
Crude petroleum	6,265 gals.
Wood	9 1-6 cords.

Used in Furnaces.

Anthracite coal	37,741 lbs.
Bituminous coal	8,081 "
Tar	2,970 gals.

Used for Boilers and Superheaters.

Anthracite coal	22,252 lbs.

Labor—2 men by day and 2 by night.

The bituminous coal (or coke) is used for starting up the fires.

Working of Lowe's Process, at Utica, for October, 1875.

Gas made	3,745,000 cubic feet.
Average candle power	18 to 20 candles.
Anthracite coal in boilers	62,300
Anthracite coal in Cupola	190,587 lbs.
Crude Petroleum	11,743 gals.

Labor—5 men; 3 by day, 2 by night.

Purification, 3¼ cents per thousand.

We give these figures as those standing on the books of the company just as we received them. There is one item not given in either case, and that is the "unaccounted for gas"—which must be taken into the account in judging of the value of the process. We believe that both of these processes court the most careful investigation. So far as we have been able to understand, the gas stands the test of cold weather fully as well as coal-gas. At Poughkeepsie the works are very complete, and there is, we believe, no other process used but the Gwynne Harris, that is, all the gas of the Citizens Company is made by their hydrocarbon process. If it cannot be made a success there, it is difficult to see how it can do so elsewhere. But time alone must demonstrate the results. The balance sheet at the end of the year, if it can be got at, will be a good test of the value of these methods.

PUBLIC GAS IN NEW YORK.

Proposals for lighting the public streets, markets, buildings, &c., in the city of New York, were opened and read at the office of the Commissioner of Public Works, at 12 M., on December 28th, by the Mayor in presence of the Comptroller and Commissioner of Public Works.

The following were the bids by the several companies "for furnishing the gas for lighting and extinguishing, cleaning, repairing and maintaining (and supplying gas, &c., for new lamps when required) the public lamps on the streets, avenues and places in the city of New York, for the period from January 1st, 1876, to April 30th, 1876, both days inclusive, the gas to be 16-candle power:"

New York Gas Light Co.,	for each lamp	..		$9 00
Manhattan	"	"	..	9 00
Metropolitan	"	"	..	14 00
Nutual	"	"	..	12 00
*Harlem	"	"	..	13 95

* The latter was as follows: For January, $4.08; February, $3 45; March, $3 45; April, $2.97.

"For furnishing illuminating gas of not less than 16-candle power, for lighting public markets, buildings and offices, for the year 1876:"

New York Gas Light Co.	....	$2 50	per 1000	feet.
Manhattan	"	2 50	"	"
Metropolitan	"	2 70	"	"
Mutual	"	2 75	"	"
Harlem	"	3 00	"	"

FROFESSOR CHANDLER'S LECTURE.

With this issue we close the lecture of Prof Chandler, delivered before the American Gas-Light Association, at its meeting last October. We would call especial attention to this address, and those of our readers who have not read it will find themselves amply repaid by a careful study of the whole of it. Some portions of the address were necessarily omitted at the time of its delivery owing to want of time; but the Professor has kindly furnished us with the whole of it, and some of the facts stated have never before been printed. Prof. Chandler is not a mere teacher, but he has had opportunities for the study of the science of gas making that render him unusually competent to speak thereon—and in giving to the gas world the valuable collection of facts embodied in his lecture he has but added to the many obligations that they were previously under to him; and at the same time contributed to the scientific literature of the day a very important paper.

Distance between Flame and Burner.

[Translated from *Journal of Gasbeleuchtung*, September, 1875.]

By T. H. Muller.

The fact that a gas flame does not touch the burner, nor the candle flame the wick, was examined by R. Blockman. Close observation shows that a gas flame does not commence immediately at the burner opening. In a bright luminous flame the contrast of the luminous part is so great as to admit of close observation; but, if the cock is gradually closed, a small space will be seen between flame and burner, which becomes more and more distinct as the flame decreases. With a slit-burner this may be carried so far that the intervening distance between flame and burner is equal to the small, half-round, non-luminous flame. This intervening space is considerably increased when the gas is mixed with an indifferent gas—as nitrogen, carbonic acid, etc. It is thereby possible to increase this intervening space, with a quick gas current issuing from the burner up to two inches and more. Blockman found that, even under very low pressure, the flame of luminous gas diluted with indifferent gases showed this increase of space between flame and burner, and therefore concluded that the cause of this rising above the burner was not the result of increased pressure, as might have been inferred from experiments, but that it was the consequence of a dilution with indifferent gas. He explained this phenomena as follows:

After asserting that not only in sounding flames, but in other flames as well, an instanta-

neous combustion always takes place in the lower part of the flame, which can only be the case when the escaping gas has mixed with exactly the right proportion of air, he finds the increasing distance between flame and burner, resulting from dilution with indifferent gases, based on the following:

"The diluted gas on leaving the burner mixes instantly with air. The constancy of the flame requires for this mixture a certain amount of combustible gas. In order now to produce in this case a combustible mixture, which contains as much gas as the one which would be produced if undiluted gas escaped from the burner, a much larger volume of gas must leave the burner—*i. e.*, the distance between burner and flame is increased."

To this somewhat forced explanation of Blockman objection is made on account of the following facts:

Except between burner and flame, this intervening space occurs everywhere when a cold object touches the flame. This temperature increases as the temperature of the object decreases, and its heat-conducting power increases. The space between the flame and the cold body introduced therein increases in the same ratio as the gas is diluted by indifferent gases, carbonic acid, etc.

If, for example, the carbonic acid is somewhat in excess, the flame may be extinguished by the smallest current of air. The more carbonic acid the gas contains, the larger will be the hole made in the flame by a thick wire. If the amount of carbonic acid is increased to such an extent that the flames will be one inch or more away from a burner tube (rolled up from sheet platinum) placed horizontally, and the tube is then heated near the open end by a Bunsen burner, the flame will approach the burner, and as soon as the platinum tube becomes red-hot the flame will commence at the outer rim of the tube without intervening space. While a non-luminous flame which contains large quantities of indifferent gas, becomes extinct for quite a large space upon the introduction of a cold, thick wire, the opening made in the flame closes gradually as the wire becomes heated. In case the wire was heated previously, there will be no space produced and the flame will touch the wire all round. In a much diluted flame these phenomena are more apparent, but even in the common gas flame they are quite distinct. All these facts force upon us the conclusion that these spaces are produced by heating influences; that the spaces are increased in flames much diluted by indifferent gases is only a consequence of the already low temperature—which in turn is a consequence of the large volume of gas which takes up the heat of the quantity of gas burned in the unit of time. It is now evident that if the temperature is already low, very little further cooling, by the object touching the flame, is sufficient to lower the temperature below the point of ignition, and the flame becomes extinct. Although these experiments prove evidently that the formation of intervening space results largely from reduction of temperature, it still would have to be considered whether this space is not partially due to effects as explained by Blockman. But that this is not the case is proved by the fact that the flame will join itself to the red hot burner-tube even when produced by diluted gases.

It seems, therefore, to be proved beyond doubt that in all these experiments the intervening space is produced solely by the cooling action of the burner, or by the same action of the cold object introduced into the flame.

Reference in the above article is made to "Reports of Chemical Society of Berlin," 1875, pp. 745 and 952; and to "Journal fur Gasbeleuchtung," 1873, pp. 345 and 419; 1874, pp. 503 and 447; 1875, p. 287.

On Noxious and Offensive Trades and Manufactures,

WITH ESPECIAL REFERENCE TO THE BEST PRACTICABLE MEANS OF ABATING THE SEVERAL NUISANCES THEREFROM.

By H. Letheby, M. B., M. A., Etc.

MANUFACTURE OF SULPHATE OF AMONIA FROM GAS LIQUOR.

Looking at the individual peculiarities of these nuisances, it is evident that they may be conveniently classified under three heads, namely:

(1). Those which are caused by the escape of noxious or offensive effluvia, as gases and vapors.

(2). Those which are produced by smoke, dust or other mechanical impurities.

(3). Those which are occasioned by the discharge of noxious or offensive matters into gutters, ditches, or water-courses.

It will not be possible to discuss in a satisfactory manner the whole of these subjects in this paper, and therefore I propose to limit your attention to the first of them, namely, to those trade nuisances which are caused by the escape of noxious and offensive effluvia, as sulphuretted hydrogen, empyreumatic or other organic vapors, and the gaseous acids.

Foremost of those operations which cause offence by the escape of sulphuretted hydrogen into the atmosphere is the manufacture of sulphate of ammonia from gas-liquor. This liquor is produced in great quantity at the gas works—varying from 10 to 40 gallons per ton of coals, according to the strength of the liquor and the perfection of the processes for removing ammonia from gas. The strength of the liquor is estimated and expressed by its gravity in degrees of Twaddell, or by the number of ounces of strong sulphuric acid (sp. gr., 1·850) required to saturate a gallon of it. This varies from 5 or 6 ounces per gallon to 25 ounces, and, according to my experience, the proportion of sulphuretted hydrogen contained in it ranges from 230 grains or rather less than one-third of a cubic foot per gallon, to rather more than 1250 grains, or nearly 2 cubic feet per gallon; so that the liquor is exceedingly offensive from the quantity of sulphuretted hydrogen contained in it; and therefore it is necessary to store it in air-tight tanks, and to transport it from place to place in air-tight vessels—as barrels or tank-barges, or tank-trucks. It is proper also that the orifices which give exit to the air at the time of filling the tanks should be guarded with a box or small barrel containing hydrated oxide of iron, which absorbs the sulphuretted hydrogen, producing sulphide of iron, which is subsequently revived by the action of the air.

The methods of treating this liquor with sulphuric acid so as to produce sulphate of ammonia have differed at different times and places. In my early experience, even in this metropolis, the process was to neutralise the liquor with brown acid of sp. gr. 1·720, and to convey the evolved gases into a furnace fire, as their escape into the air would be dangerous to the workmen; and the saturated liquor still reeking with sulphuretted hydrogen was evaporated in open lead troughs over open fires. The nuisance arising from these operations was absolutely unbearable; and as people got to be more and more sensitive of annoyance, the old process was discontinued. At the present time the practice is to evaporate or distil the liquor from closed boilers or chambers, and to convey the volatile products—ammonia, carbonic acid, and sulphuretted hydrogen—into a closed chamber, or saturator, containing weak sulphuric acid, there being a contrivance for the escape of carbonic acid and sulphuretted hydrogen, and the conveyance of them to a furnace fire. In some cases the liquor is distilled from boilers set over a common fire; but, as this is liable to flushes and irregularity in working, it is objectionable, and has given place to the process of distilling by means of a steam coil set in the boiler, by which steam at from 20 to 30 lbs. pressure is blown into the liquor. But the best contrivance of all is that known as Coffey's still, which consists of a vertical chamber from 20 to 25 feet in height, having a series of transverse septa which alternately leave an opening at their ends. In this way, with about sixty of such septa, a superficial area of about 1000 square feet of evaporating surface may be obtained. The liquor is delivered in a constant and graduated stream at the top of the chamber, and as it flows backwards and forwards in a descending current over the transverse septa, it meets with an ascending blast of steam which is let into the bottom of the chamber at a pressure of from 15 to 30 lbs. In this way the volatile constituents of the liquor are carried over to the saturator, where the ammonia is arrested by sulphuric acid, and the exhausted liquor flows out in a continuous stream from the bottom of the chamber. The saturator is generally an air-tight leaden vessel, about 4 or 5 feet square and 3 or 4 feet deep, containing a charge of diluted sulphuric acid—equal parts of chamber acid (1600) and water. When the acid is saturated with ammonia, which is known by test-papers, steam alone is blown into it from the still for about half an hour to displace all traces of sulphuretted hydrogen, and the solution is drawn off into open pans or troughs, where it is evaporated by means of a closed coil of high pressure steam set in the solution.

Another kind of saturator occasionally in use is a leaden vessel divided into two compartments by a diaphragm or curtain, which descends below the liquid to within about 18 inches of the bottom. One of these compartments is closed air-tight and receives the volatile products of the still, where they meet with a graduated stream of brown acid (sp. gr. 1·720), which continually neutralises them, and forms crystals of sulphate of ammonia, which are constantly ladled out of the open compartment. The apparatus is ingenious, and saves much labor and time in evaporation, as the acid is saved in its undiluted condition; but it is not so certain or satisfactory in its action as the closed saturator before described.

In both cases the uncondensed gas—sulphuretted hydrogen and carbonic acid—with much steam, are conveyed from the saturator through a 4-inch pipe to the furnace fire, where the sulphuretted hydrogen is burnt. It is necessary, however, that the sulphuretted hydrogen should be deprived of its moisture before reaching the fire, or it will extinguish it; and this is effected by throwing the pipe into coils, or otherwise cooling it. The precautions, therefore, to be taken in the conduct of this business are:

(1). The transport and storage of the gas-liquor in air-tight tanks guarded with boxes of hydrated oxide of iron.

(2). The distillation of the liquor in a steady and continuous manner in air-tight stills by means of high-pressure steam.

(3). The saturation of the ammonia in close vessels, and the complete expulsion of sulphuretted hydrogen from the saturated solution before it is drawn off for evaporation.

(4). The condensation of moisture from the sulphuretted hydrogen evolved from the saturator; and the conveyance of the cold dry gas to the furnace fire where it is to be completely burnt.

(5). The treatment of the exhausted liquor from the still with cream of lime, so as to recover the residual ammonia by a second distillation; or, if the process be in operation at a gas-works, the use of the residual ammonia as an absorbent in the purification of gas.

(6). The observance of the greatest care as regards the tightness of the apparatus at all parts.

Hydrogen as a Source of Heat and Light.

By Dr. A. W. Hofmann.

Compiled from the *Chemical News*, Sept. 24th to Nov. 5th.

We return, therefore, to its applications as a source of heat and light. It has been briefly described in the section on oxygen how the oxyhydrogen blast was evolved from the experiments of Saron between 1780 and 1790, and how it was introduced in the manufacture of platinum in the middle of the present century by Deville and Debray. Since 1838* Desbassians de Richemont found in hydrogen mixed with air the means for the autogenous soldering of sheets of lead, and thus supplied the sulphuric acid manufacture with the fundamental condition of its growth, *i. e.*, permanent lead chambers of any desired magnitude. If, in places where coal-gas is readily procurable, this combustible is substituted for hydrogen in soldering lead, many sulphuric acid chambers are not near gas-works, and in them hydrogen is still necessary for soldering. The same must be said on the application of hydrogen for the autogenous soldering of other metals and alloys, a process for which Winckler, in his convincing essay already quoted, predicts a great future. More recently lead pans soldered in this manner have been introduced in the manufacture of boracic acid in Italy. Numerous conflagrations, especially that of Canterbury Cathedral in 1871, and that of the Alexandra Palace on Muswell Hill in 1873, demonstrably due to the braziers full of fire used in soldering the leaden spouts, which led, in England, to the proposal to solder leaden roofing and spouting with hydrogen.

How far hydrogen is superior to other kinds of fuel appears from the following table. According to the experiments of Favre and Silbermann, 1 grm. of the following bodies, when burnt in water, gave the appended number of calories, *i. e.*, it raised, by 1°, the temperature of the given number of centigrammes of water:

Hydrogen	34·462
Carbonic oxide	2·403
Oil of turpentine	10·852
Stearic acid	9·716
Alcohol	7·814
Marsh-gas	13·063
Wood charcoal (burnt to carbonic acid).	8·080
Ethylen	11·858
Ether	9·028

The temperature of the flame does not, however, depend exclusively on the heat of combustion. The density of the burning body and the specific heat of the products of combustion must also be taken into account. Hence it comes that the temperature of the hydrogen flame in pure oxygen is about 6800°, in air about 2600°; the temperature of the flame of carbonic oxide in oxygen amounts to 7000°, in air about 3000°;† further according to calculation 1 vol. of hydrogen=1 grm. is capable of fusing 205 grms. of platinum, whilst the same volume of carbonic oxide can fuse 238 grms. of platinum (melting-point 2000°.) In practice, however, even under the most favorable conditions, as Deville and Debray determined in their researches on platinum, about half the heat is lost by conduction to the furnaces and other surrounding matter, and the above authorities with 120 litres of hydrogen and 60 of oxygen succeeded in fusing only 1 kilo. of platinum instead of double the amount as calculated. Platinum can also be smelted and refined under similar circumstances with coal-gas. But for the more infusible metals of the platinum group, iridium, ruthenium, and their alloys, the hydrogen flame must be retained, which, if costlier than coal-gas, is cheaper than carbonic oxide.

In the use of gases as fuel the metal itself can be brought in contact with the flame, which is impracticable in case of carbon, and thus the great loss of heat is avoided which ensues when the crucible is heated from without. Their application renders it also possible to inspect the condition of the metal at any moment. In the metallurgy of the common metals these two advantages do not come into consideration. Carbon, moreover, is not only the cheapest but the most productive fuel,* and the application of hydrogen as a source of heat seems therefore limited to autogenous soldering and to the fusion of the most refractory platinum metals.

The property of platinum-black to ignite hydrogen, of which Döbereiner made a well-known and widely utilized application in his hydrogen lamp in 1823, has lost its practical importance owing to the discovery of friction matches.

The more intense and permanent was the interest which hydrogen created as a source of light.

As the luminous power depends on the temperature at which a solid ignited body is maintained the suggestion was near at hand to produce an intense light by means of this gas, in which an incombustible body was heated to whiteness. To this end the Scotch military engineer Drummond used in 1826 cylinders of caustic lime heated in the oxyhydrogen flame. The Drummond light has been widely employed, not merely in geodetic measurements and in lighthouses, which the inventor had principally in view, but also for projections of microscopic objects and photographic images on glass, or drawings upon gelatine for demonstration in lecture-halls,† for dissolving views, and chromatropes. In the American civil war it was used in seiges to light up forts.‡ The English war department has tried it in barracks, in large halls and courts, in which‖ it is said to have proved cheaper than coal-gas, whilst the smallest characters could be read at a distance of 90 metres from the source of light.

Since lime partially loses its luminous power by continued use, platinum-wire magnesia, and latterly zirconia, have been employed in its stead. §

The above-mentioned applications of the hydrogen lamps are, however, of a very limited nature. To utilize it on the large scale for street lighting, the simultaneous use of oxygen has been laid aside, and cheaper methods of preparation have been sought for. For this purpose, advantage was taken of Felice Fontana's method of decomposing water by means of ignited iron and ignited carbon, as proposed in 1780.¶ On the latter scheme Donovan founded his industrial preparation of hydrogen gas in Dublin in 1830. His process has been repeatedly described with modifications, referring in part to the needful apparatus, and in part to the diminution of the proportion of carbonic oxide. The presence of this poisonous gas was at first justly urged as an argument against the use of the "water-gas." Langlois found that the mixture obtained—on allowing steam to pass over iron retorts filled with red-hot coke in Kirkham's apparatus—had the tolerably constant composition of 58 to 60 per cent. of hydrogen, 19 to 26 carbonic oxide, and 15 to 20 carbonic acid

It was subsequently, however, discovered* that at higher temperatures carbonic oxide is oxidized by watery vapor to carbonic acid, so that if the steam is in excess a gas may be obtained relatively free from carbonic oxide, as shown in the reaction—

$$C+2H_2O=4H+CO_2.$$

In the water gas prepared at Narbonne, where the gas on issuing from the retorts is conducted through ignited tubes along with fresh quantities of superheated steam, Verver† found in 1858, 3·54 per cent. of carbonic oxide. According to other observers the amount ranged from 2·5 to 5 per cent. In the water-gas at Passy, Payen found 6 per cent. of carbonic oxide, whilst in ordinary coal-gas he found an average of no less than 14 per cent. The above-mentioned objection, therefore, no longer holds good.

The carbonic acid is removed by milk of lime, or, perhaps, more economically, according to the suggestion of Heurtebise‡ by soda, which is thereby converted into bicarbonate, a readily saleable substance.

Faves‖ constructed for lighting the town of Narbonne an apparatus which he named gazogen, which furnished in twenty-four hours 1000 to 1200 cubic metres of purified gas, the cost of which, independent of labor, and of the cost and depreciation of plant, he calculates as follows:—

Per 100 Cubic Metres of Gas.

		f.	c.
75	kilometres of coke at 0·03 franc	2	25
55	" coal at 0·025 "	1	37
82	" lime		82
		4	44

The material costs, therefore, 4½ centimes per cubic metre.

Instead of decomposing water by carbon, certain other processes have recently come into use, and require notice.

Lenoir's process,§ suggested in 1867, is of very limited applicability. He decomposed barium sulphide with water, obtaining sulphate of baryta and hydrogen—

$$BaS+4H_2O=BaSo_4+4H_2.$$

This process is only practicable where the manufacture of barium sulphate (permanent white) is the main object, and the hydrogen a by-product, as was the case with Lenoir.

Tessié du Motay and Maréchal¶ have introduced a valuable modification into practice, as they require no steam-boiler for the manufacture of the water-gas, and thus economize fuel, whilst the wear of the simplified apparatus is considerably reduced. They heat coal with soda, hydrate of lime or of baryta in iron retorts, and thus decompose the combined water of these bases, which is then freed from carbonic acid in the ordinary manner. This precedure has been adopted by the New York Oxygen Company, who, in the manner described above, sell water-gas at the enormous price of 2 cents per cubic foot, or 1 cubic metre for 3s. 6d ** The mixture of lime and anthracite is heated in retorts such as those described above under Tessié du Motay's method of preparing oxygen.

The decomposition takes place at a red-heat, according to the equation—

$$C+CaO+CH_2O=CaCO_3+2H_2,^*$$

and lasts about fifteen minutes. Thereupon hydrate of lime is re-formed by passing steam over the heated mass. The carbon is not exhausted until after three weeks, and is then replaced by a fresh supply of anthracite.

That coal-gas contains large quantities (30 to 50 per cent.) of free hydrogen, and that the proportion of this ingredient rises, the higher the temperature of the retorts in preparing the gas, has long been known. Tessié du Motay and Maréchall, whilst introducing the above-described precedure, have taken advantage of this circumstance, and have passed coal-

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*Karmarch, "Geschichte der Technologie," 380.

‖ Debray, "Sur la Production des Temperatures Elevees et sar la Fusion de la Platine." Lecons de Chimie en 1861, 65; Paris, 186

*The calculated temperature of the flame of carbon in oxygen is 10,000°, from which has to be deducted the unknown amount of heat which at this temperature is lost by dissociation. See Debray, *Opus citat.*

† This Report, p. 14; also H. Vogel, *Ber. d. Chem. Gesell.*, iii., 901.

‡ Wagner, "Lehrbuch der Technologie." 9th edit., ii., p. 377.

‖ *Journal of Gas-lighting*, 1866.

§ *Mem. Soc. Ital.*, xv.

¶ See the work of Phillips, quoted above.

* Bromeis, *Zeitsch. d. Ver. deutsch. Ing.*, iii., 82, and *Dingler Polyt. J.*, clxiv. 33, 1859

† B. Verver. "L'eclairage au gaz a l'eau a Narbonne et l'eclairage au gaz Leprince." Lieden, 1858. See Bromeis, *opus citat.*

‡ Heurtebise, *Dingl. Pol. J.*, cxxcvi. (?), 393, 1867.

† Fayes, *Genie industriel*, 1868, 329. *Dingl. Pol. J.*, clix. 47.

§ Lenoir, *Wign. Jahresber*, 1867, 219, 259.

¶ *Bull Soc Chim.*, 1868, 1., 334.

** H. Vogel, *Ber. Chem. Ges.*, iii., 901.

gas over lime in order to resolve it into carbon, hydrocarbons boiling at high temperature, and large quantities of hydrogen. At the same time E. Vial* adopted the same method, and has doubled, and even trebled, the yield of gas by "decarburation." Schinz† doubts the industrial value of this process, on account of the outlay for fuel, and calculates that the decomposition of water by means of coal yields a luminous gas for half the cost of coal-gas. Here, however, as we shall presently see,, the depreciation of the plant has not been taken into account.

If we now inquire in what manner the hydrogen, however obtained, is rendered luminous, we find two essentially different methods. The one depends on mixing the water-gas with hydrocarbons. As early as 1834‡ Selligue employed, at Paris, the oils obtained by distilling the marl-shales of Autun in order to saturate the water-gas with gaseous hydrocarbons. White subsequently passed the water-gas through retorts in which rosin or coal was converted into luminous gas, and his process was carefully examined in 1851 by Frankland,‖ who concludes a laudatory report with certain propositions, of which the following are the most important:—

1. The production of gas from given weights of common coal or of cannel is increased by 46 to 290 per cent., according to the quality of the material employed.
2. The luminous power is increased by 12 to 108 per cent., the more when coals are employed which produce gas of a strong luminous power.
3. The quality of the residual tar is lowered, a part of it being converted into gas of a strong luminous power.

It must be remarked that tar had not at that time the value which it has subsequently reached.

White's process recurs, with trifling modifications, under a variety of names.

As the "système Leprince," or "gas mixte Leprince," it was introduced into industrial concerns at Liege, adopted by the town of Mastricht, and by some departments of the Vieille Montagne at Verviers, and was critically described by Verver in 1848 in his work above quoted. Four years afterwards a similar precedure was elaborated by Baldanus and Grüne,§ for which Schäffer and Walcker obtained a patent in Prussia. Their process consisted in passing steam through retorts in which coal-shales, turf, and other combustibles were heated to redness. It differs, therefore, from White's process herein that the production of hydrogen and its carburation are effected in the same retort. An ordinary gas retort 8½ feet in length is said to yield, in twenty-four hours, 8,000 to 9,000 cubic feet of this gas; and in Wagemann's manufactory at Benel, near Bonn, where this process has been introduced, 1 cwt. of coal-shale was consumed per 1,000 cubic feet of gas.

Essentially different is the second method of employing hydrogen for lighting, as carried out in 1846 by Gillard, at Passy, near Paris. He fixed on the burners,¶ from which the water-gas issued, baskets of platinum wire, which, on the ignition of the gas, were heated to brilliant whiteness. Hence it was called platinum gas (*gas platine*). The immobility of the light, even in a strong wind, the dispensing with lamp-glasses, which, according to Verver, absorb 22 per cent. of the light, and the brilliance obtained on this principle, must be considered as advantages, although the intensity is not free from objections. its use was not continued at Passy, but it was introduced by the celebrated firm of Christofle & Co. into their electro-plating works at Paris,** and was employed to light the streets of Norbonne. The hourly consumption of gas being 3·234 cubic feet (=0·1 cubic metre), the light was equal to that of 5·22 normal candles, and, though the lamps at Narbonne were placed at intervals of 50 metres, Verver pronounced the lighting of the streets as perfect.

* Vial, *Genie Industriel*, 1869. *Dingl. Pol. J.* cli., 382.
† Schinz, *Dingl. Pol. J.*, cli., 388.
‡ Dumas, "Handbuch der Chemie," vii.
‖ Frankland, *Ann. Chem. Pharm.*, lxxxii., 48.
§ *Journal fur Gasbeleuchtung*, 1862, p. 68.
¶ Report by O. Henry, *Journ. Pharmacie* [3] xvii., 105; *Dingler's Journal*, cxvi., 222; and the Reports of Bromeis and Ververs.
** Wagner, "Handbuch der Technologie," 1873, ii., 371.

Latterly, since the preparation of hydrogen has been improved by Tessié du Motay and Maréshal, new attempts have been made in Paris to light up large squares and streets with "platinum gas." Spectators, however, may find justification for the caricatures in the Parisian comic journals of that time, which represent the passengers in the streets, and infants in arms, and the very dogs in the gutters, equipped with eye-shades to preserve their sight.

Technical literature has the peculiarity that it records the introduction of novelties, but leaves us in the dark concerning their practical verification. It keeps a tolerably exact register of the births of inventions, but gives a very imperfect account of their career in life and of their deaths. Thus with a single exception, we are left in the dark as to the permanent results of lighting with hydrogen.

The experiments made with water-gas at the town of Elizabeth, in New Jersey, yielded unsatisfactory results, as made known in 1865.* Great depreciation of plant, heavy working expenses, and disproportionate consumption of fuel were the causes of failure.

It was, therefore, the more desirable to ascertain in how far the process had proved successful in Europe, and, thanks to the kindness of several correspondents, we have succeeded in obtaining information. The fate of the method in Belgium appears from an extract from a letter which M. L. de Koninck, Professor of Chemistry at the University of Liege, kindly forwarded to the present writer:—

The *systeme Leprince*, which consists in the introduction of small quantities of water into the retorts in which coal is distilled, had for a short time a certain success (*une certaine vogue*), depending mainly on numerous reclamations by which it was helped out. Its chief advantage was supposed to lie in the fact that it drove the gas out of the retort, a purpose for which an exhauster or aspirator is now preferred. The system has never been employed for public purposes in Belgium, but merely in certain manufactories. Since the death of the inventor, which took place some years ago, it is no longer spoken of, and has been generally, if not universally, abandoned. This has been the case at Vieille-Montagne. *

In a letter dated March 18, 1874, M. Landolt, Professor of Chemistry at the Polytechnic School of Aachen, confirms these statements. The use of water-gas is continued only in Cockerill's works at Seraing. At Simoni's cloth-works at Verviers the process never advanced beyond the stage of unsatisfactory experiments, although certain technological papers have asserted to the contrary. In Maestricht where the water-gas was used for some time for public purposes, it has, as Professor Landolt has been informed, failed to give lasting satisfaction, and has been replaced by coal-gas two years ago (1872). Direct inquiries addressod to the municipal authorities have remained unanswered.

The above statement of the introduction of the Drummond light in English military establishments led to an inquiry being addressed to the Chemist to the War Department, Mr. Abel, of Woolwich, from whom the following courteous reply was received, under date April 20, 1874: "As regards your inquiry concerning the introduction of the lime-light in military premises I have to communicate that at the period you mention experiments were made for a short time in two of our establishments, but that the question of its formal introduction has never been seriously entertained."

The illumination of the galvano plastic works of Christofle with water-gas was likewise of brief duration, and the process has been long ago abandoned. We are indebted to this firm for the following communication under date April 21, 1874: "In reply to your letter of the 17th we have to state that the use of hydrogen in our works came to an end in 1353 on account of certain difficulties (*inconvenients*) which presented themselves, and that we have no longer preserved the documents bearing upon the matter."

It only remained to ascertain the fate of the so-called platinum gas at Narbonne. To do this with certainty there appeared no other method than to appeal to the courtesy of the municipal authorities. The Mayor of Narbonne had the kindness to comply fully with our request, and to sign the following instructive and characteristic letter, dated March 16:

"The relations of Prussia and France since the war impose upon me the greatest caution as regards inquiries. As the question, however, is one of a purely scientific nature, I have handed over your letter to the Abbé Prax, chemist to the Agricultural Society of Narbonne, who has for a long time occupied himself with this subject. I have the honor to enclose a copy of the memoir which he placed in my hands."

Account of the Water-gas in Narbonne from 1855 *to* 1865.

"In May, 1855, I was sent to Paris by the municipality to test the water-gas of Passy. My report was dated June 8, 1855. The town adopted this method of lighting and heating and came to an agreement with the company called the 'Narbonnaise.'

"From 1856 the Passy system was in use in Narbonne. We modified the burners in several respects, as those of Passy were not sufficiently lasting. The high temperature of the retorts occassioned from time to time the loss of a furnace, and after many losses the system of retorts was abandoned in favor of another apparatus, the 'Cubilot' (Fayes apparatus). Towards the end of 1858 it was heated with wood charcoal, which soon gave place to coke on account of its costliness. At the same time we made important changes in the burners and platinum baskets, the latter of which were suspended instead of resting on the former.

"The illumination with hydrogen is brilliant but sensitive (*delicat*). The lamps in the streets must be well closed, as a gust of wind distorts the ignited platinum wick. The dust introduces sand, which forms a silicide of platinum, and this metal ultimately assumes an injurious crystalline structure and is even partially volatilized.

"In Narbonne all care was wanting towards the end of the career of the company Narbonnaise. The manager, M. Crouzet, became a wine merchant in Paris. All superintendence was withheld, and the lighting became at last intolerable. In June, 1865, therefore, coal-gas was introduced. As far as heating is concerned nothing can in my opinion compete with water-gas in convenience and cheapness.

"PRAX,
"Chemist to the Agricultural Society.
"Narbonne, March 15, 1874."

On the evidence of these documents the precedures for illumination with hydrogen hitherto employed must be condemned if anything further is desired than the display of objects and transparencies for the lecture-room or the stage.

Hydrogen lighting was not represented at the Vienna Exhibition—a further indirect evidence that it had not found any wider application.

An objection, long known, depends on the high coefficient of diffusion of hydrogen, and its consequent ready escape through the pores and fine chinks of the mains, a circumstance the more dangerous, as hydrogen is not, like coal-gas, at once detected by its odor. The diffusion-coefficients of gasses, according to Graham's experiments, are inversely as the square roots of their specific gravities.

* Wagner, *Jahresberichte*, 1865, 758.

Reruse Water from Cloth Manufactories.—The waters in question are derived from fulling and rinsing woolen cloths, and are estimated to contain the oil used in spinning, to the amount of 15 per cent. of the weight of the wool, and the soap employed in fulling, which is 30 per cent. of the weight of the cloth. The author recommends that these waters should be collected in appropriate tanks, precipitated with milk of lime, and that the lime soaps thus formed should be decomposed with sulphuric acid. The total waste for the whole of Europe is estimated at 2,125,000 cwts. of fatty matters.—*M. Reimann's Fosber Zeitung.*

Third Annual Meeting of the American Gas-Light Association.

HELD AT MASONIC TEMPLE, NEW YORK, OCTOBER 20TH, 1875

ADDRESS OF PROF. CHANDLER.

[Continued from page 224.]

The loss of light by the use of shades, chimneys, etc., is very considerable and largely due to the conversion of light into heat. The following numbers, selected from the results of William King of Liverpool and Prof. F. H. Storer of Boston, are a sufficient illustration:

Description of glass.	Thickness of Glass.	Loss of Light.
Clear glass (King).....	.....	10·57
Ground glass "	.....	29·48
Smooth opal "	.....	52.82
Ground opal "	.....	.55.85
Thick English plate (Storer).....	½ inch.	6.15
Crystal plate "	¼ "	8.61
English crown "	⅛ "	13.08
Double English window "	1/16 "	9.39
Double German (Belgian) Storer	⅛ "	13.00
Single German (Belgian) "	1-16 inch.	4.27
Double " (Belgian) ground (Storer).....	⅛ "	62.34
Single " " " "	1-16 "	65.75
Berkshire, Mass. ground (Storer	1·66 "	62·74
Orange-colored window glass (Storer).....	1-16 "	34.48
Purple " " " "	⅛ "	85.11
Ruby " " " "	1-16 "	89.62
Green " " " "	1-16 "	81.97
A porcelain transparency.....	1-16 "	97.68

Lighting gas by electricity has recently been introduced in theatres, halls, etc., with great advantage. As it is an instantaneous operation, it results in great economy by rendering it unnecessary to light the gas before it is actually wanted, and in sparing the attendants the great exertion required in applying the torch at great heights. It may be effected by stretching a fine platinum wire above each burner, and heating it to a white heat by a current of electricity when the gas is turned on. A better plan is to use the Ruhmkorff coil. In this case each burner is isolated from the house-pipes by a hard rubber connecting ring. A series of wires is then arranged by which the electric current is made to leap in sparks to the tip of each burner in succession when the gas is turned on. Systems have been invented by which the gas of the street-lights is turned on and off and lighted by electricity from a central office.

Pressure.—As already stated, a certain amount of pressure is required to force the gas through the street-mains, house meters, pipes, and burners. The pressure is measured by the height of a column of water supported by the gas in a U-shaped tube, one end of which is open to the air, while the other is connected with the gas-supply. It is estimated that there should be a pressure of one inch at the entrance to the premises of every consumer, 0.2 inch being required to force the gas through the meter, 0.2 inch for the house-pipes, and 0.6 inch for the burners. This pressure is exerted by the weight of the great gasholders at the works. Were the consumption of gas uniform during the entire twenty-four hours, the holder could be properly balanced once for all, and a uniform pressure would be exerted at all times—four or five inches are found to be necessary for large districts...but when no gas is burned, no pressure is required, and when little gas is burned, four or five inches would be excessive. Consequently, the pressure must be graduated according to the hourly consumption. For this purpose the *governor*, already mentioned, is employed at the works to regulate the flow, and consequently the pressure, of the gas from the holder to the street-mains. The following table exhibits the variation in pressure caused by irregularities of consumption. The holders of the New York Gas-Light Co are on East 21st street; its district extends from Grand street to the lower end of the island at Whitehall street Hester street is well within the district.

Pressure of the Gas in Inches of Water.

	3 P.M.	4 P.M.	5 P.M.	6 P.M.	7 P.M.	10 P.M.	12 P.M.
21st street...	1.7	2,	5.5	4.2	2.9	1.9	1.0
Hester st....	1.6	1.7	2.4	2.2	1.9	1.6	1.2
Whitehall st.	1.0	1.	0.6	1.1	1.1	1.0	0.8

It is thus seen that a uniform pressure throughout the district supplied is absolutely impossible. In order to secure a sufficient pressure at the extremities of the district, an excessive pressure must be produced at the intermediate points; and as the pressure must be varied from hour to hour at the works, it will vary at the premises of most of the consumers. The consumer must therefore regulate the pressure for himself; (1) by carefully adjusting the main cock at the meter; (2) by adjusting the cock at each burner; (3) by using check burners; (4) by attaching a regulator at the meter. It sometimes happens that the consumer cannot get sufficient pressure to supply his burners, when he of course fails to get the light he requires, and concludes that the gas is poor. This difficulty may be due to several causes: (1) insufficient pressure at the works. (2) the street-mains are too small or are obstructed; (3) the service-pipe is too small or obstructed: (4) the meter is too small or out of order; (5) the house-pipes are too small or obstructed; (6) the fixtures are obstructed; (7) the burners are too small, defective, or obstructed. By comparing notes with neighboring consumers, and consulting an intelligent gas-fitter, the real cause of the deficient light can generally be ascertained. In large buildings there should be a separate cock and regulator on each floor to prevent irregularity of pressure.

The illuminating power of gas is dependent upon several conditions: (1) liberation of solid particles of carbon from the olefiant gas and rich hydrocarbon vapors by the heat of the flame, or the oxidation of the hydrogen at points in the flame where the supply of oxygen is not sufficient for both hydrogen and carbon: (2) to the temperature of the flame, which renders the carbon particles luminous: (3) to the density of the materials burned: (4) to the density of the products. These conditions depend upon the chemical composition of the gas and the manner of its combustion. Gases rich in olefiant gas and heavy hydrocarbons furnish the most luminous flames. The character of the burner, the dimensions of the chimney with argands, and the pressure determine the manner of combustion by regulating the supply and admixture of air. A low pressure with a burner that secures a supply of air just sufficient to prevent smoking—*i. e.*, the escape of unconsumed carbon—secures the maximum amount of light. The pressure and quality of the gas being fixed, it was formerly supposed that the light produced was directly as the rate of combustion, and that consequently two like burners consuming each 3 feet of gas per hour would give the same amount of light as one similar burner consuming 6 feet. Recent investigations make it extremely probable that the amount of light increases as the square of the consumption. (*Farmer's Theorem.*) Consequently, the light from the two burners would be $3\times3+3\times3=18$, while that from the one 6-foot burner would be $6\times6=36$. Thus, the large burner gives twice as much light for the same consumption as the two small burners; hence, the economy of a few large burners over many small ones.

Carburetting or Carbonizing Gas.—It having been established that the illuminating power of gas depends upod the presence of heavy hydrocarbon vapors, numerous means have been contrived and patented for adding such vapors to the gas. The materials available are the naphtha of coal-tar, and the naphtha of petroleum or coal-oil. Coal-tar naphtha is by far the most effective, though most expensive. It consists of benzol, C_6H_6, and its homologues, which are very dense and very rich in carbon. Petroleum and coal-oil naphtha consist of hydrocarbons of the marsh-gas series (see petroleum), such as quintane, C_5H_{12}; sextane, C_6H_{14}; heptane, C_7H_{16}, etc., in which the ratio of carbon to that of hydrogon is less than half what it is in benzol, etc. Dr. Letheby (*Chem. News*, xi., 1865, p. 124,) found that while 1 grain per cubic foot of gas of some naphthas increased the illuminating power 9 per cent., the same quantity of other naphthas raised it only 1·99 per cent. Under favorable circumstances he found that a gallon of coal-tar naphtha would enrich 6000 feet of gas, adding over 10 grs. per cubic foot. and increase its illuminating power 68 per cent., thus making it equal to 10,000 feet of the original gas. The practical gain is 4000 feet, costing the price of 1 gallon of naphtha, about $1. The conditions which effect the carbonization are, (1) quality of the gas, (2) quality of the naphtha, (3) construction of the carburetter, (4) temperature of the carburetter. The last condition is very essential to success. If the carburetter is placed in a warm situation the naphtha evaporates too rapidly, the gas becomes overcharged, and the flames smoke. The burners must be adjusted to the character of the gas, and if the gas varies from day to day from irregularity in the carbonization, the annoyance becomes intolerable. Another difficulty arises from the condensation of the naphtha in the house pipes and fixtures, by which they become obstructed and cease to deliver gas. These difficulties have led to the ill-success which has attended this apparently logical method of enriching gas.

The Specific Gravity Test.—As already stated, the chief diluents of coal gas are hydrogen, specific gravity 0·069, and marsh-gas, 0·559, while the luminants are olefiant gas, 0·976, propene, 1·49, butene, 1·94, benzol, 2·71, naphthalene, 4·43, etc. The specific gravity of the mixture will depend, to a certain degree, on the ratio of heavy luminants to light diluents. This does not hold true in the presence of any considerable quantity of carbonic oxide, specific grav. ity 0·967, as when water gas is a component, or of air as in the Rand and Gale naphtha gas. The table which you see before you, and which is from Muspratt's "Chemistry," will sufficiently illustrate the relation of specific gravity to illuminating power in coal gas made by the usual process. The specific gravity was formerly determined by carefully weighing the gas in a light glass globe provided with a stop cock, making suitable corrections for temperature and pressure. Recently, a very simple method has been introduced. by which the operation can be accurately performed in a few minutes. The diffusive power of gases being inversely as the square of the density, the density will be directly as the square of the diffusion. It is only necessary to determine the number of seconds required for equal volumes of air and of the gas to escape through the same opening, and to divide the square of the gas-seconds by the square of the air-seconds the result is the specific gravity of gas.

As the square ot air seconds is to the square of gas seconds, so ais 1 (sp. gr. of sir) to x (sp. gr. of gas).

W. W. Goodwin, Esq., of Philadelphia, supplies the simple apparatus for this determination under the name of the "density test." (See *Am. Chemist*, ii., 177, 216.)

Name of coal.	Cu. ft. of gas per 2240 lbs.	Illuminating power in candles.	Sp. gr. of the gas.
1, Ponesfield.....	10,500	11.50	.398
2, Gosforth.....	10,000	12 00	.402
3, New Pelton.....	10,500	12.00	.415
4, West Hartley.....	10,500	12.50	.420
5, Pelaw.....	11,000	12.75	.420
6, Hasting's Hartley.....	10,300	12.50	.421
7, Leverson.....	10,800	12.50	.425
8, Pelton.....	11,000	14.00	.430
9, Washington	10,000	14.00	.430
10, Dean's Primrose.....	10,500	13.50	.430
11, Blenkinsop.....	9,700	14.00	.450
12, Washington cannel...	10,500	18.00	.500
13, Pelton cannel.....	11,500	18.50	.521
14, Leverson cannel.....	11,600	18.00	.523

Gas from Coal Tar.—Ever since the manufacture of coal-gas became an established industry the importance of converting the tar into gas, or of so conducting the destructive distillation as to prevent its formation, has been fully recognized, and the greatest variety of processes has been patented, all of which claim to make *more gas and better gas* from ton of

coal. The actual possibilities are estimated by comparing the weight of tar with the weight of gas from the same coal; 2240 pounds of average caking coal yield from 9000 to 10,000 cubic feet of gas of a specific gravity of, say, 0.430, equivalent to 296.86 or 329.84 pounds of gas. The same coal yields, say, 12 U. S. gallons of tar, the specific gravity of which is from 1.12 to 1.15, or 9.33 to 9.58 pounds per gallon, equal to 112 to 115 pounds. If this tar could be entirely converted into gas of .430 specific gravity, it would add 3394 to 3488 cubic feet to the yield of gas. The case is still more striking when, as in some cities in England and Scotland, cannel coal is exclusively employed, cannel coal yielding 10,000 cubic feet of gas having a specific gravity of .500, or 383.5 pounds of gas, yields, say, 30 gallons of tar, specific gravity 0.990, or 247.38 pounds of tar, which, if converted into gas of spetific gravity .500, would add 6449 feet to the yield of gas. The proportion of carbon in coal tar is so great, however, that under no system can it be converted into gas without the formation of a considerable proportion of fixed coke, probably from 25 to 40 per cent. of its entire weight. This fact reduces very considerably the possible gain of gas from the tar; in the case of caking coal, the usual material, from the 3394 to 3488 cubic feet of gas to not much above 2000 feet. To secure this gain, the tar, which has a market value of from 33 to 50 cents per ton of coal, must be sacrificed, and more complicated apparatus and a larger consumption of fuel and labor must be resorted to. It is for these reasons that none of the methods suggested for producing gas from the tar have as yet been successful.

In 1818 John Grafton patented the conversion of the tar into gas by delivering it into a second retort, heated to redness and filled with iron filings, coke, etc. In 1820 Mr. Lowe contrived an arrangement of five retorts—three below and two above—for the same purpose. The retorts were charged in the usual way with coal, and when the carbonization had gone on for three hours, the tar was admitted into the back part of the upper hotter retorts by a syphon tube. Some have mixed the tar with small coal, others with peat, sawdust, porous stones, etc. In 1827 Bernard Chaussenot patented in France the use of one vessel or retort heated to a low temperature for distilling "resin and all hydrogenous matters liquid and solid" into rich vapors, and a second retort heated to a high temperature for converting these vapors into permanent gas. This principle has been the basis of numerous patents—Robertson (in 1848), Gesner (1849), Hanson (1853), Gale (1858), Fryer (1868), Eveleigh (1870?), etc. While this principle has not been successful if applied to coal alone, it is probably essential to the production of gas from petroleum or any of its products, and is in successful operation in several works where petroleum naphtha is used as an enricher for coal-gas, as at the Harlem and the Mutual works in New York, the Citizens' and the People's works in Brooklyn, and many others. This is, after all, but a subdivision of the process which actually takes place in every coal retort, as I have already stated. The coal is always distilled at a low heat, and the condensable vapors are subsequently conqerted into permanent gas after they leave the coal.

By-Products of the Coal-Gas Industry.—The by-products of the manufacture of coal-gas consist of (1) coke. (2) ammoniacal liquor, (3) tar, (4) the spent lime or oxide of iron used in purification. The *ammoniacal liquor* is the source of nearly all the ammonia salts of commerce. By far the larger part of the nitrogen of the coal, which varies from less than 1 per cent. to nearly 2 per cent., is not converted into ammonia; it forms cyanides, sulpho-cyanides, bases, etc. The strength of the ammoniacal liquor depends chiefly upon the amount of water used in washing and scrubbing the gas. The strength of the liquor is estimated in degrees (Twaddle), or by the number of ounces of oil of vitriol required to neutralize a gallon. Each degree of Twaddle is equal to about two ounces of acid per imperial gallon. The liquor varies from 3 deg. Tw. to (10 or 11 deg. Tw. The maximum yield of ammonia is perhaps 45 gallons of 8-ounce liquor per ton of coal, equivalent to 34 pounds of sulphate of ammonia. The ordinary yield is about 25 gallons of 8-ounce liquor, equivalent ts 20 pounds of sulphate of ammonia. In L ndon only abont half this quantity is obtained. In 1866 there were obtained at the Paris gas works 3000 tons of ammoniacal products, either sulphate or aqua-ammonia, from 421,000 tons of coal, or 0,712 per cent., or 16 pounds per ton. The ammoniacal liquor contains the ammonia in the form of hydrosulphate, acid carbonate, cyanide, sulphocyanide, chloride, and benzoate. By mixing it with lime and blowing steam through it the ammonia is expelled, and conducted to vats containing sulphuric acid. where it is absorbed and combined as sulphate, which is obtained in crystals on evaporation. This salt is used as a fertilizer, in the manufacture of alum, and for the preparation of other ammoniacal compounds.

The Tar.—The quantity of tar obtained from a ton of coal varies with the character of the coal, and the temperature to which it is exposed. The higher the heat the smaller the yield of tar. Eleven to eighteen U. S. gallons is the usual yield from caking coals, the average being about twelve gallons. The Paris gas-works averaged 12¼ U. S. Gallons in 1866. Formerly there was no market for the tar, and it was thrown away. Of late years many uses have been found for it, and it has been a source of revenue to the gas companies. It is used as a rough paint or varnish for wood and iron, for waterproofing paper and felt for roofing and other purposes, for the manufacture of pitch for roofing and paving, and for the preparation of a great variety of useful and beautiful products. In fact coal tar is one of the richest sources of valuable products known to the chemist, and its study has yielded an extremely rich harvest, both to theoretical as well as to practical chemistry, and has exerted a controlling influence on some of the most useful arts, and even upon the agriculture of large districts.

Coal-tar is a very complex mixture of organic bodies, and consists largely of what are called aromatic compounds. Let me again call your attention to the diagram which shows the more important products from coal. Under the heading tar you see nearly forty hydrocarbons, eight alcohols, four acids, twenty-one bases, and no one can say how many oxidized and other compounds which have not yet been identified.

The crude tar is subjected to distillation in large stills, and is separated into four portions or fractions:

1. The light oil of tar, which is lighter than water.
2. The heavy oil of tar, or "dead oil," which is heavier than water.
3. The green or anthracene oil.
4. The pitch which remains behind in the still.

The light oil of tar consists chiefly of benzol, toluol, etc. It is rectified and sold under the name of coal-tar naphtha, as a solvent for making varnishes, etc. From the residue, "or tailings," is prepared the beautiful crystallized carbolic acid, so valuable as a disinfectant, and also as a material for preparing picric acid, the beautiful yellow dye, and the constituent of some of the new explosives. The most recent application of carbolic acid, which is not properly an acid but a phenol, a kind of alcohol, is for the preparation of salicylic acid. This acid exists in oil of wintergreen, which is the acid salicylate of methyl. Kolbe found that this acid could be made from carbolic acid by combining it with caustic soda and exposing the compound to carbonic acid gas at a high temperature. Half the carbolic acid is set free and distils over from the retort in which the operation is conducted, while a compound of salicylic acid with soda remains behind from which hydrochloric acid separates the new acid. Here is a beautiful specimen of the produet. It appears as a white crystalline powder almost colorless and with little taste. If Kolbe's labors had ended with the discovery of this simple method of preparing this acid, you would never have heard of it, but he discovered the wonderful antiseptic properties of salicylic acid, and pointed out a thousand useful applications for it, so that it is now manufactured in large quantities. It is more powerful as an antiseptic than carbolic acid, while its freedom from taste and smell and its harmless character when taken internally give it a far wider range of usefulness. It can be used to prevent the souring of wine, beer, milk, in fact of all articles of food. It is extremely useful in checking certain diseases, which appear to depend on the rapid development of minute living organisms, *bacteria*, such as diphteria, etc. It is probable that we do not yet half realize the valuable purposes which this acid is capable of serving.

Besides the yellow picric acid, several other beautiful dyes are prepared from carbolic acid—for example, phenyl brown or phenicienne, grenarte brown, coraline or pacenine, a scarlet dye, and azuline or phenyl blue.

By proper rectification the coal tar naphtha is made to yield nearly pure benzol, or the mixiure of benzol and toluol, which is the foundation of the great aniline industry. By subjecting the benzol to the action of nitric acid it is converted into this yellow "oil" or "essence of mirbane," nitrobenzel or as it is commonly called artificial oil of bitter almonds. This is very useful as a substitute for the real oil of bitter almonds for perfuming soap, lotions, etc. It is not really artificial oil of bitter almonds although it has the same odor. By subjecting this nitrobenzol to the action of iron turnings and acetic acid, and distilling with caustic soda we obtain this dark oily liquid which is aniline, a strong base capable of uniting with acids and forming salts. Toluol another constituent of the coal tar naphtha, yields a similar series of products under like treatment, nitro-toluol, and toluidine, a base which you see is solid, but otherwise similar to aniline.

By subjecting a mixture of aniline and toluidine to the action of agents which remove hydrogen, such as a mixture of arsenic and hydrochloric acids, corrosive sublimate, bichloride of tin, etc., a salt of a new base, rosaniline is produced. This is the primary aniline color. Rosaniline itself is colorless but its salts are of the most beautiful pink or cherry color in solution, while they appear as crystals with the most beautiful green metallic lustre. As I turn this jar of crystals you can see the brilliant flashes of green and golden light from the faces of the crystals, reminding you of the Brazilian beetles.

By subjecting this aniline red to the action of iodide of methyl, or ethyl, or to the action of aniline itself, it changes to purple, violet, and finally to the most beautiful blue. The operator having it in his power to stop at any desired shade between the red and the full blue. Let me call your attention to these jars which contain solutions of a dozen or more of these different shades of red, purple, violet, and blue; and to these silks, worsteds, and cottons which have been dyed with them.

You see we have also greens, yellows, oranges, browns and blacks among our specimens, these are all products of further changes in our aniline, by processes which our time will not permit me to explain. The black is the most intense and permanent that can be produced upon cotton. It is actually made in the fibre by applying the materials to the cotton cloth, and causing them to react and produce the black by exposure to steam.

The heavy oil of tar consists chiefly of hydrocarbon oils, which are not specially interesting. It also contains naphthalene, this beautiful white solid, which is the basis of some beautiful colors, made by processes similar to those used in producing aniline colors. We have this bright Martinvs or Manchester yellow, which is a calcium or sodium salt of binitro-naphthalinic acid; this fine Magdala red, which is a distinct base, prepared from naphthylamine by agents which withdraw hydrogen. Then we have these naphthaline blues and violets.

The heavy oil contains carbolic and cresylic acids, and on this account is a valuable source of these antiseptic and disinfecting agents. The oil as a whole is an effective agent for preserving timber from decay, and as a disinfecting agent for sewers, privies, cattle-

pens, etc. Thousands of gallons are used every summer in this city by the health department, for disinfecting the privies of the 25,000 tenement houses. Half a gallon of dead oil, costing 4 or 5 cents, and half a gallon of saturated solution of copperas, costing a like sum, diluted with a pail of water, is sufficient for an ordinary privy. The cost of material being not over 10 cents, and the cost for labor, carts, etc., about as much more.

The green oil, which comes over after the dead oil, has recently become very important, and is now the basis of a new and extensive industry. The most important dye-stuff used is the madder root, and its various preparations. They produce on cotton, with proper mordants, all shades and colors from a light pink to red, purple, lilac, violet, chocolate and black, and these colors withstand soap better than any others. To them we are indebted for the calicos or prints which are manufactured to the extent of millions of yards every year.

Graebe and Liebermann have succeeded in tracing alizarine, the coloring matter of madder, to coal tar, to the anthracene, this beautiful white crystalline hydrocarbon which is contained in the green oil of tar.

Several methods are now in practical operation for converting anthracene into alizarine, twenty factories are in operation in Europe, every steamer brings us a consignment of artificial alizarine for our print works, and the Dutch and Alsatian farmers are ploughing up their madder fields and sowing wheat and other food crops.

All the calicoes on this end of the table were printed with artificial alizarine. Here are two pieces of like pattern, one dyed in madder, the other in the artificial alizarine, the sharpest and most experienced eye cannot distinguish any difference in their tints. An important result of these discoveries is the cheapening of these necessaries of life, which is sure to follow such additions to our manufacturing resources.

The Refuse Oxide of Iron.—The oxide of iron is used over and over again, being regenerated by exposure to the air, by which the sulphur extracted from the gas is liberated from the iron and left as free sulphur. When the proportion of sulphur reaches 40 or 50 per cent. the mixture is treated for the extraction of ammonia salts and sulphur, the purified oxide of iron being then returned to the gas-works to be used again. The refuse iron contains considerable cyanogen, which may be extracted by potash and sold as yellow prussiate. The *spent lime* is very offensive when fresh, as explained under purification, and is useless for any purpose. After being weathered, however, it may be used with advantage as a fertilizer. Dr. A Völcker gives the following analysis of weathered gas-lime; dried at 212° F.:

Caustic lime	18·23
Carbonate of lime	49·40
Sulphite of lime	15·19
Sulphate of lime (gypsum)	4·64
Magnesia and alkalies	2·53
Oxide of iron and alumina	2·49
Phosphoric acid	a trace
Insoluble sand, etc	0·28
Water of combination, with a little organic matter	7·24
	100·00

The fresh gas lime contains considerable sulphide of calcium and hyposulphite of lime, which makes it useful for removing the hair from hides.

PETROLEUM AND NAPHTHA GAS.

Had I not already consumed much more of your evening than I intended, I should discuss somewhat in detail the many processes which have been suggested for making gas wholly or in part from petroleum, naphtha, or residuum. At this late hour of the evening I can only make a few general remarks on this topic.

For a long time many doubted the possibility of making a permanent, uncondensable gas from these materials. There is no difficulty, however, in doing this. Petroleum is a mixture of hydrocarbons of the marsh gas or paraffine series, the members of which constitute an homologous series, that is differ from each other by a common difference of CH_2. The first member of the series is the marsh-gas, or methane, CH_4, which is one of the chief constituents of coal-gas. The second is ethane, C_2H_6, the third, propane, C_3H_8, and so on.

As these paraffines become more complex they become less and less volatile, their boiling points become higher and higher, and as soon as the boiling point is higher than the temperature of the air, the paraffine appears as a liquid. Finally, the melting point becoming lower and lower, falls below the temperature of the air, and we have solids. If you glance at this diagram you will see the entire series of hydrocarbons of which petroleum consists.

You see that the first three are gases, while the last members of the series are solids, the substance known in commerce as paraffine, In the refining of petroleum this series is separated by fractional distillation into several portions; the first or, most volatile, consists chiefly of the third, fourth and fifth members of the series, the gases escaping condensation. The burning oil, or kerosene, includes the twelve or fifteen members next following. The residuum includes the last members, and yields the solid paraffine and the lubricating oil. This diagram shows the various commercial products as obtained by fractional distillation.

The refiner is not obliged to produce any heavy lubricating oil unless he chooses to do so, as by the

THE PARAFINES, OR MARSH GAS SERIES OF HYDROCABONS.

Names.	Formulæ. C_nH_{2n+2}	Carbon.	Hydrogen.	Boiling points. Degrees F.	Sp. Gr.	Density Beaume.
Methane, marsh-gas	CH_4	75.00	25.00	A gas.		
Ethane	C_2H_6	80.00	20.10	A gas.		
Propane	C_3H_8	81.81	18.19	A gas.		
Butane, Quartane	C_4H_{10}	82.80	17.20	34	0 600	106
Quintane	C_5H_{12}	83.33	16.67	86	0.628	98
Hexane	C_6H_{14}	83.72	16.28	154	0.669	86.5
Heptane	C_7H_{16}	84.00	16.00	200	0.699	72
Octane	C_8H_{18}	84.21	15.79	242	0.726	64.5
Nonane	C_9H_{20}	84.38	15.62	278	0.741	60.5
Decane	$C_{10}H_{22}$	84.51	15.49	321	0.757	56.5
Endecane	$C_{11}H_{24}$	84.61	15.39	360	0.765	54.5
Dodecane	$C_{12}H_{26}$	84.70	15.30	388	0.776	52
Tridecane	$C_{13}H_{28}$	84.78	15.22	422	0.792	48
Tetradecane	$C_{14}H_{30}$	84.85	15.15	460		
Pentadecane	$C_{15}H_{32}$	84.90	15.10	496		
	$C_{16}H_{34}$	85.04	14.96			
	$C_{20}H_{42}$	85.11	14.89			
	$C_{23}H_{48}$	85.18	14.82			
	$C_{25}H_{52}$	85.23	14.77			
Paraffine	$C_{27}H_{56}$	85.26	14.74	Solid.		31.5
Paraffine	$C_{36}H_{62}$	85.31	14.69	698		

Products of the Distillation of Crude Petroleum.

PRICE IN BULK, 14 CENTS PER GALLON.

Gravity. Beaume.	Name.	Percentage yielded.	Gravity, Beaume.		Price per gallon. In bulk.	Price per gallon. Retail.
Gases.				Uncondensed, Loss.		
115°B. to 105°B.	Cymogem		110°	Condensed by pump, made by one firm only for an ice machine, boils at 32°F.	$1.50	
105°B. to 95°B.	Rhigolene		100°	Condensed by ice and salt, used as an anæsthetic, boils at 65°F	$1.00	
95°B. to 80°B.	Gasolene	1½	85° to 90°	Condensed in worm by cold water, used in "air gas machines" and gas "carbonizers."	35 cents to 18 cents	
80°B. to 65°B.	Naphtha	10	71° to 76°	For *oil cloths*, cleaning, etc.; so-called "safety oil," "Danforth's oil," "American Safety Gas," etc.; for adulterating kerosene; cleaning oil wells.	7 cents to 5 cents	12 cents to 20 cents
65°B. to 60°B.	Benzine	4	62° to 65°	For paints and varnishes	16 cents to 12 cents	20 cents to 16 cents
60°B. to 38°B.	Kerosene or refined petroleum.	55	46°	Ordinary oil for lamps	20 cents to 25 cents	30 cents to 40 cents
38°B. to 25°B	Paraffin oil	19½	30°	Semi-solid when cold. Chilled and pressed to separate paraffine, oil used for lubricating	18 cents to 14 cents	
	Coke gas and loss	10				
	Total	100				

process of cracking, distilling very slowly in high stills, he can split up the heavy hydrocarbons into lighter or less complex oils. Thus C_{20} H_{12} may "crack" into C_{10} H_{22} decane, and C_{10} H_{20} decene, or into decane, nonane C_9 H_{20} and fire carbon. When petroleum or any portion of it, either the light naphtha or the heavy residium is exposed to a red heat, by running it into red hot retorts, in a liquid stream or in vapor, it is cracked in the same manner, but into simpler products, producing a rich permanent incondensable gas, consisting of marsh gas CH_4, ethane C_2 H_6, propane C_3 H_8 etc. There is no reason, therefore, why petroleum and its products may not yield permanent gas of high illuminating power.

Much fear was expressed lest the gas should "stratify" in the holders. Stratification can only result in two ways, either by the heavier (richer) gases settling from the lighter ones, and forming a separate layer, or from an irregular production, due to variations of the heats, by which rich heavy gas is produced at one time and light poor gas at another. The first way is impossible, gases never separate after they have been once mixed. I know this is contrary to the popular opinion, which believes that carbonic acid settles because it is 50 per cent. heavier than the air, but it never does, and the theories of ventilation which are based on the supposition that the carbonic acid preponderates near the floor are all false. The most impure air in a room is always near the ceiling, because it is the warmest. Gas will not stratify after it has been once mixed. The other cause, irregularity in the production, may cause a *temporary* stratification; I say temporary, because gases will mix no matter how much they differ in specific gravity, but a certain amount of time is necessary to make the mixture uniform.

The real question at issue is, whether it will pay to make gas from petroleum, naphtha or residium. The ways of making it are numerous. Some propose to use no other material, and to convert the petroleum or naphtha into a permanent gas and burn this alone. Others propose to dilute the naphtha gas with air, others with coal-gas, others with water-gas. Others again load coal-gas or water gas with naphtha vapor and pass the mixture through a red hot retort to crack the naphtha vapors into permanent gases, or to mix the naphtha vapor or gas with steam, and to pass the mixture through red hot retorts.

All of these processes may be made to yield rich gas. Some can be carried out with much more regularity and certainty than others. Some result in the rapid destruction of the retorts, etc., others do not. Never having had an opportunity to personally test these various processes I can only speak generally of them. I do not believe that gas can be made wholly or chiefly from petroleum, or any of its products, at the present time. A few small companies may use considerable quantities of naphtha, but if the New York city companies should all adopt it the price would be doubled at once—perhaps trebled. Naphtha wrighs seven pounds to the gallon; a ton is consequently 320 gallons, and a ton of petroleum under the most favorable circumstances can only produce a ton of gas. One thousand feet of rich gas with a specific gravity of 0.700, such as might be made from naphtha, would weigh 53.69 pounds. Supposing the ton of naphtha to be converted into this gas with no loss whatever, no carbon, no tar, etc., we could get from a ton, or 320 gallons, 41,721 cubic feet, and should have no coke, tar, or ammonia water to help pay for the coal. From these data alone, it can be shown that there is no profit in naphtha gas, except when naphtha is permanently less than five or six cents per gallon, which, with the present production it can never be if the larger companies use it. When used as an enricher the conditions are quite different, and I have no doubt that in many localities it may be and is used with profit in place of other enrichers. As it is now in use in several different ways in this city and its neighborhood, you will have an opportunity while here to see it in practical operation. It is a mistake to suppose that naphtha gas is a better gas for consumers than good coal-gas. Seventeen candle gas, such as is furnished by our city companies is as rich as is desirable. Gas much richer than this is sure to smoke, at least at times, and the products from partially burned gas are very objectionable, they discolor the pictures and walls, and are very oppressive to the lungs.

WATER GAS.

By passing steam over red hot carbon, charcoal, coke, or anthracite, it is decomposed into hydrogen and carbonic acid, and if the carbonic acid remains long enough in contact with the red hot carbon it is canverted into carbonic oxide.

$$2H_2O + C = 4H + CO_2$$
$$CO_2 + C = 2CO.$$

When the decomposition is complete the resulting gas is one half hydrogen and one half carbonic oxide. Neither of these possesses any illuminating power, but by using the mixture to dilute rich naphtha gas, a mixed gas of any desired illuminating power can be produced. I doubt very much, however, whether the cost of water gas is any less, considering the fuel used and the wear of apparatus than coal gas, and it is certainly no better as a diluent; in fact it is inferior, as the flame of gas rich in carbonic oxide is very easily extinguished by draughts of air, to which street lamps are always exposed.

OXYGEN GAS.

A few years ago considerable excitement was created in gas circles by the new "oxygen light." It was proposed to extract oxygen from the atmosphere by a new and cheap process, and obtain light by using a compound jet supplying oxygen gas and coal gas, and directing the flame upon cylinders of lime or zirconia. Experimentally the new light was a great success, and works were erected in Paris, New York and Buffalo. Notwithstanding the fact that the idea was condemned as impracticable by all intelligent gas engineers, the stock found ready takers. The complete failure of the project followed in due time. The oxygen cost many times as much per 1000 feet as coal gas, on account of the small yield from each retort, and the rapid wear of the retorts, etc. Two sets of mains, meters, house pipes, and new fixtures were too serious an investment to be possible. The coal gas required carburetting to be used in burners not provided with lime or zirconia. For some time the affair was kept before the public, but it finally died out. In New York it was always "*a success in Paris and Buffalo,*" and in Paris it was *a great success in New York.*

Before closing I will say a few words with regard to some of the advantages of gas. I am well aware that the public generally do not look upon gas companies as public benefactors, but they may be certainly regarded as such. The great safety, comfort, convenience and cleanliness of gas, added to its great illuminating power, place it far beyond any other kind of light. One of the objections to it is on account of its smell, but in that lies its safety, as we are thus enabled to know when it escapes.

It is cheaper than candles or any animal or vegetable oil. Its only rival is petroleum. That is cheaper, though in point of comfort, convenience, cleanliness, and safety, of course there is no comparison.

I am ashamed to have presented these commonplace and well known facts before such an audience as this, but as I accepted the invitation, I was compelled to carry out my contract, and could not of course hope to say much that was new to you on this subject

I thank you, gentlemen, for your courtesy and attention.

The lecture was illustrated by many beautiful and interesting experiments.

On motion a vote of thanks was tendered Professor Chandler.

Adjourned until Thursday morning, the 21st inst., at 10 o'clock.

SECOND DAY'S SESSION.

OCTOBER 21, 1875—10 O'CLOCK A. M.

The Association met persuant to adjournment, and was called to order by the President.

The President—You see, gentlemen, that we have a smaller and much more comfortable room for the transaction of our business.

Mr. Neal—I do not suppose it is necessary to make a motion to dispense with the reading of the minutes of the meeting of yesterday; but as such is usually the custom, I now make that motion,—to dispense with the reading of the record of yesterday's proceedings. Carried.

Mr. Neal—Before Mr. Edgerton resumes the discussion of the subject upon which he was speaking yesterday afternoon, I would like to say a word or two. Many of the members of the Association felt disappointed when the Secretary announced yesterday that our business would be completed by noon to-day. Now, many of us have come from a long distance, expecting this meeting to last two days at least. There was a great deal of time lost yesterday in organizing the meeting, and the Secretary necessarily occupied considerable time in collecting the dues of new members.

Now I, with others, would like to discuss some subjects, or hear them discussed. I could mention a few that were brought before the New England Association of Gas Engineers, but were not very thoroughly discussed before that body. One of the subjects to which I allude is "Napththalne;" another topic is "Coal Tar for fuel in Benches;" another is "Lime Purification;" and I think there are a great many members who, like myself, would be very glad to hear these questions fully discussed.

I saw last evening a cube of spent lime. I think Mr. Turner, of South Carolina, had it. I would like to have him exhibit that to the Association.

Now, I am willing to spend three days here, I mean another day in addition to this, for the purpose of having these topics, and any others that may be started, fully ventilated. We might, after the morning hour expires, adjourn and partake of the dinner to which we have been invited, at two o'clock, and reassemble at three or half past three, for the transaction of business. An hour or an hour and a half will certainly be sufficient time. Then, I think we might meet again in the evening, or I should be glad to remain here another day, and continue the consideration and discussion of these various subjects, but I do not suppose the majority of the members of the Association could spare the time to do that. Therefore, Mr. President, as the naphtha gas topic has been discussed pretty freely and at some length, and as there are other subjects of as much or more importance to come before us, I move that the discussion of the naphtha gas question be closed at half past ten o'clock.

The President—How much more time do you want, Mr. Edgerton.

Mr. Edgerton—About 10 minutes.

Mr. Neal—Mr. Edgerton says he can close his remarks in 10 minutes. I do not think there are any others who wish to say anything further on this question, and I would move, therefore, that the discussion of this question be closed at half past 10. Carried.

Mr. Harbison—I think the discussion should close at 20 minutes past 10. We spent a greater part of the afternoon yesterday on the subject, and, for one, I have heard all I wish to in regard to it, and I move you, sir, that the discussion of this question be closed at 20 minutes past 10.

[To be continued.]

AN ALLOY OF COPPER ADHERENT TO GLASS.—An alloy of copper which will adhere to glass or porcelain is made by mixing from 20 to 30 parts of copper in powder (obtained by the reduction of the oxide by hydrogen or by the precipitation of the sulphate by zinc), with sulphuric acid and then with 7 parts of mercury. The mixture is triturated and mingled with care. The acid is removed by washing in hot water, and the mass allowed to dry, At the end of 10 or 12 hours, the latter becomes quite hard and susceptible to a fine polish. On heating it softens, but on cooling does not contract. This alloy may also be used for joining delicate objects which will not withstand very high temperatures.

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AGENTS

NEW YORK—AMERICAN NEWS COMPANY, 119 and 121 Nassau St
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PHILADELPHIA—COE, WETHERILL & Co., Ledger Buildings, Phila.
Germany—B. WESTERMANN & Co., of New York.

MONDAY, JANUARY 3, 1876.

Purification of Gas in Closed Vessels.

In the *Journal of Gas Lighting* for November 30th is presented the following suggestion from the pen of Mr. Geo. Anderson. We are sure that the well-known ability of the author will secure for his letter a careful study, and in reproducing the cut of the apparatus it is our desire that the proposed process be discussed in our columns. We shall gladly publish any discussion on the subject:—ED.

SIR: In my reply to the discussion on my paper on the "Purification of Gas" (session of the British Association of Gas Managers for 1874) I made use of these words:

"I believe we are approaching an era (and it will depend very much on gas managers themselves whether it will be inaugurated more or less speedily) when all the gas will be purified without lime purifiers—when it will be done in closed vessels, and they will not have to take off the lids."

I spoke thus, because I had in my mind that the common ammoniacal liquor which the coal yields can, and does, when employed first in washors and then in scrubbers, remove a large quantity of both carbonic acid and sulphuretted hydrogen.

But if after the washer and scrubber you could again bring the gas into contact with ammoniacal liquor from which carbonic acid and sulphuretted hydrogen had been removed, you would again make it active, when it would be in a condition to continue the process of purification.

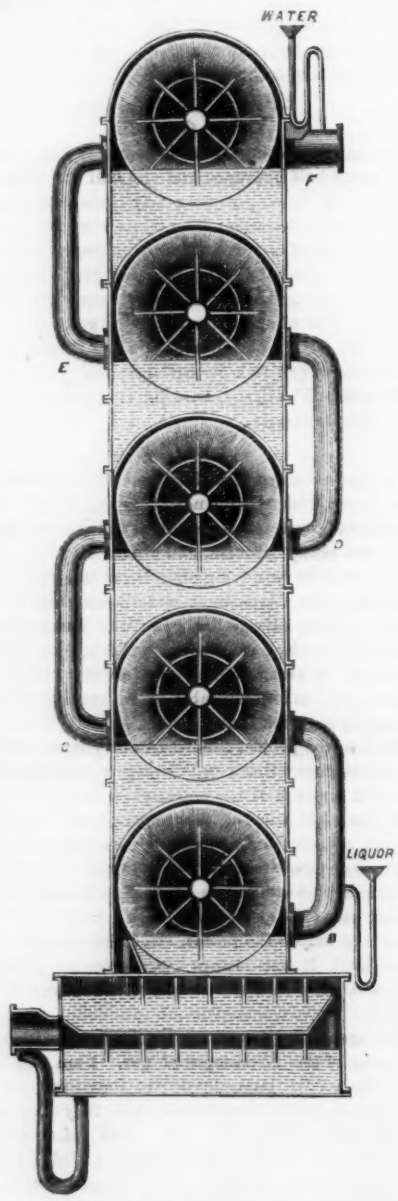
Now, the question that arises is, cannot the sulphide that is necessary for the reduction of the sulphur compounds be made by the alkali ammonia instead of by the alkali?

If it can, then with the coal itself, and with efficient apparatus, we have all the elements necessary to the production of pure gas, and it may be done in closed vessels. The purification of gas in closed vessels is not new. I mention this in case some "dog should bark."

In thinking out this question, I have been constantly met by the opposition which I find many gentlemen have to employing washers, as their exhausters are unable to force the gas through them.

This is a defect of the exhauster, yet we must take things as we find them. I, therefore, began to consider how we could get an intimate contact of the gas with the purifying liquid without causing much increased pressure, and think I have solved that.

Passing my stable, I saw the groom using a new whalebone fibre broom. I took it in my hand and examined it. There were strong elastic fibres about 4 inches long, pretty closely set. It occurred to me if one could constantly wet these and cause the gas to pass through between a long succession of these fibres, they would be sure to scrub the gas, if the liquid was of the proper kind, and from that idea I designed the machine shown below.



It consists of a short length of my washer for a base, on top of which is erected a vessel, divided horizontally into a number of chambers, into each of which there is a circular drum, whose periphery is one continuous brush. The upper side of each of those partitions forms the bottom of a shallow tank of water, into which the brush drum above it dips.

The under side of each of these partitions forms the gas-way, in which the brushes revolve.

This machine is intended to act as an ordinary washer and scrubber, or as a purifier from either carbonic acid or sulphur compounds.

When acting as an ordinary washer and scrubber, pure water to the extent of 10 to 12 gallons of water to each ton of coal (Newcastle) used, would be run in at the top. This will pass down the pipes on the sides up which the gas travels, passing through each chamber in succession until it arrives at the washer, through which it will pass with the addition of the ordinary liquor of the works, which will be run into it towards the bottom as shown; and the entire liquor thus treated will run out at the seal-pipe at the opposite or left-hand side of the section, as shown.

The course which the gas takes will be, first, through the short portion of washer, which may be made to give from 2 to 3 inches of pressure, or any greater amount, the chief object of its use being to arrest tar from getting up among the brushes, where only clear liquid is wanted.

On issuing from the top of the washer, the gas will pass round the upper portion of the lowest brush from left to right, up the side pipe *b*, round the second brush, from right to left, and out at *c*, and so on throughout the whole of whatever number of brushes it may have to pass through.

The brushes might be considerably increased in number, and, consequently, the height of the machine; but it should be observed that the distance which the gas has to travel, in passing round the braches, is considerably more than the vertical height of the machine; besides, it may be found advisable, instead of having flat pipes for the upward passage of the gas and the downward passage of the water, to have them of boxes the whole length of the machine, and charged with some material to present a wetted surface, as in an ordinary scrubber, which, if satisfactorily applied, would further add to the distance the gas would have to travel through a purifying medium, without increasing, to an inconvenient height, the altitude to which the purifying liquid must be raised to enter at the top.

I propose that the brush-drums shall slowly revolve in an opposite direction to the gas, and, as this is alternately right and left, a band passed zig-zag round pulleys on the exterior of the shaft that carries the brushes will move the whole in the direction necessary.

All this has been gone carefully into, but to represent it would require more drawings than are necessary for the practical readers of the *Journal of Gas Lighting*. What is aimed at is that the gas shall pass through the coarse fibres of a revolving brush, which shall constantly lick up the liquid in which the lower part of it is immersed, and present it to the foul gas.

Whether I am correct in the chemical views which I hold as to being able to purify the whole of the gas by the products of the coal, I do not consider yet proved; but that the annexed figure will perform the functions now delegated to washers, I have not the least doubt. One part I have thoroughly tried; the other—the brush part—is now in action at one place and will be in another before long; but I do not intend now to imitate the little boys who halloo before they are safely out of the woods.

Upon your insertion of the foregoing, I will send the *modus operandi* of using those vessels for the entire purification of gas, leaving for the present purifiers the duty of collecting the sulphur for sale to the manufacturers of sulphuric acid

Nov. 25, 1875. GEORGE ANDERSON.

Correspondence

[Correspondents, in all cases, should sign their communications with their names and address in full—not for publication, unless desired, but as a guarantee of good faith.—ED.

Street Loss Accounts.

SAN FRANCISCO, November 25, 1875.

Mr. Editor; Mr. Somerville will probably be newly surprised at *official* figures of street loss recently sent you for publication.

Before proceeding to furnish you with others, it cannot be too distinctly stated that the amount of gas *sold* per ton is the true criterion of the gas maker's ability. This issue of gas *paid for per ton* is the one which any sensible Board of Directors should consider paramount to all others; for it includes the important components of high heats and judicious retort management, sound station-work, tight mains and services, the delivery and calculation of proper volumes to public lamps, and proper sizes and efficient repair of consumers' meters. It is common enough for a superintendant to talk of inaccurate station meters; but how *can* a station meter be inaccurate if

properly handled, and supplied with a properly adjusted automatic water-line gauge? And as to another question: How can any vagaries (inexcusably permitted) of a station meter affect the quantity of gas delivered to public lamps and consumers' meters, or the revenues pocketed therefrom?

In spite of the fearful bosh which was formerly uttered about that trinity of bugbears, "condensation," "exosmose," and "endosmose," no gas-maker of average study now believes that they can cause appreciable loss. The other, *and true*, causes of discrepancy are, each and every one of them, controlable; as we shall find, by and by, when we come to sum up.

I received a day or two since the returns of the Crystol Palace District Gas Co., England, through the unsolicited courtesy of its engineer, Magnus Ohren, Esq.; but before giving it I would urge upon every American company my renewed request for like data. Good, bad, or indifferent, I hope that all will be furnished, and thus enable me to build up a little book which, without compromising the name of a single company, will do more to develope the real availabilities of the coal-gas process, and to fortify it against attacks, than anything that has yet appeared. To accomplish this useful end, a small company can do nearly if not quite as much as a large one.

What with the Pelouze and Audouin condenser, the immediately forthcoming "Synopsis," the Mindeleff process for reducing metals by light carburetted hydrogen, and my wish to turn this "street loss" question inside out, I have deemed it well to resign my connection with the San Francisco Gas-Light Co. Being thus at liberty to consider the issues of our great industry from an independent stand-point, I shall endeavor to make my labors generally useful.

Returning from this digression, I give Mr. Ohren's figures, although they do not come within the definition of "*American* Street Loss Accounts."

LETTER III.

CRYSTAL PALACE DISTRICT GAS CO.—SYDENHAM.
Half-year ending June 30, 1875.

			Per ton.
Gas sold to consumers, through meters			8.324 c. f.
Gas sold—to meters and lamps, and used through meters on works, offices, etc,			9,242 "
Gas made from station meter			10,025 "
GAS BALANCE.			
Gas sent out	167,673,000	c. f.	
Gas registered on private meters	138,443,000	" =	82.6 p.ct.
Gas registered for lamps regulated to 5 feet	13,118,000	"	7.8 "
Gas registered as used in offices, works, etc.	2,164,009	"	1.3 "
Gas unaccounted for	13,948,000	"	8.3 "
Total	167,673.000	"	100.0 "

(Signed) MAGNUS OHREN, Eng'r.
November 1st, 1875.

As to the American companies, here is the fourth letter permitted to be published.

LETTER IV.

From * * * * Esq., Treas. * * * Gas Co.

OFFICE OF THE * * * GAS CO.,
October 9, 1877.

James R. Smedberg, Esq.,
Consulting Eng'r, etc., San Francisco.

Dear Sir: Yours of 1st inst. is before us. I cheerfully comply with your request as follows:

1st. From 1868 to 1874, both inclusive, our sales averaged 9,172 cubic feet per ton of coal carbonized. This includes all gas used by the company at offices and works. Minimum quantity averaged for any one year, 8,791. Maximum ditto, 9,620.

2nd. Average quantity registered per ton of coal carbonized, for time as stated above, 9838 cubic feet. Minimum quantity averaged for any one year, 8,476, maximum ditto, 10,018.

3rd. In 1871 our city commenced to lay water pipes, which increased our loss about 50 per cent. Previous to that, there had been no definite plan for laying pipes of any kind; consequently the gas pipes had been laid almost anywhere in the streets; but generally they were laid under direction, so far as location was concerned, of the highway surveyor, so that in laying the water pipes our gas pipes were undermined at all points.

Soon after the city commenced to lay water pipes sewers followed, which interfered with our pipes even more than the laying of water pipes.

From these facts I feel justified in saying that had our pipes not been disturbed as stated. our loss from all causes would not have exceeded five per cent. annually for the seven years.

The probable point of greatest loss is more a matter of opinion than of actual knowledge with me. In general terms, I should say it is, in our case, about evenly divided between mains, services and meters. The older mains were often made of poor iron, cast horizontally and so side-heavy, the thin side naturally at the top when laid resulting in weakness where the services were tappad in, beside being defective in other respects, and probably little or no attention given to inspecting and testing. We now have all our pipes cast perpendicularly, and tested under a pressure of 300 lbs. to the square inch. We use cement joints with tarred rope packing.

We often have trouble with old services, especially when laid in wet ground, and near the salt water. Being wrought iron, they rust out much sooner than cast iron, and often leak a long time before we discover it.

Having long been satisfied that it would be economy to have all our meters removed and tested at least once in two years, in the early part of 1874 we commenced to do so, and are now at work on them. The result so far still more confirms me in the opinion that all meters should be tested as stated.

4th. We prefer the dry meter, if properly constructed shall be able to say more about meters when we have completed one round in testing.

5th. Is answered in my answer to your third question, but would say generally that we are more particular in doing all our work of laying pipes, etc., and have pipes made of good iron, even thickness, thoroughly tested and well laid.

Whenever a street is to be newly paved, we go on and relay and generally enlarge the services where necessary. These, together with the thorough inspections and periodical testing of the meters, constitute the principal means of keeping down our "leakage."

There are many things that are not always noted that enter into the cause for what is called leakage. Among others are the condition of the gas when measured, holders covered in from the weather or exposed, depth at which the mains are laid, pressure of gas in the mains, etc., etc.

I need not mention these things, for I know you are much more familiar with them than I am. Unfortunately for us, our holders are so located and mains so laid, that we are practically obliged to carry too heavy a pressure during the day—2½ to 3 inches.

For fear that I am too long-winded for your patience, I will close by saying that there are no works of much size immediately about here; but I will endeavor to do what I can for you in this matter. Shall be pleased to receive a copy of your report when completed.

Very truly yours,
(Signed) * * * * Treas.

REMARKS.—For several years the street loss of this company, which may be designated as "C," has been twice as great during the first half of the year, as that brought to record during the last half. It is not stated whether it is the ton-sales, or the ton *registration* which varies. Were this datum in our possession, it would not be difficult to explain a phenomenon which, after all, is not so very unusual. Respectfully,

JAMES R. SMEDBERG.

Gas-Light Intelligence.

United States.

At a meeting of the Brooklyn Board of Aldermen on Monday, the Committee on Gas and Lamps were instructed to make an investigation and ascertain without unnecessary delay whether some other method cannot be adopted for lighting the city than that which is now in vogue, or whether the city could be lighted as well by oil as with gas. The greatest cost of street lighting is $600,000 per annum.

The manufacture of a barrel of petroleum into a fixed gas can be accomplished at a less cost than into refined oil. Numerous works for this purpose are now in operation, and more are being erected, while the cheapness with which they can be built and operated puts gas light within the reach of the smallest communities, instead of confining it to the cities, as is and must be the case with coal gas.—*Anthracite Record.*

Great Britain.

The notice of a bill to be promoted by the South Metropolitan Gas Co., of course finds a place in the *Gazette*. The first wish of the company appears to be to get repealed the sections of their Act of 1869, which relate to the penalties recoverable with respect to the illuminating power and purity of their gas, and to the mode of testing such power and purity. What this may portend, it is impossible to say. Possibly 16-candle gas, with any amount of the so-called impurities.

The Chartered Co., in the first place, are desirous to obtain powers for the acquisition of, collectively, a large area of land; part of it for the extension of their western works, which will soon be urgently required, and a part to provide for the further enlargement of the eastern establishment, the necessity for which must be looked forward to, and the land to allow of it obtained.

In the notice now referred to, there is a paragraph which seems to hint at the possibility that the Chartered Co. contemplate operations for the utilisation of residual products. We should regard this, if really intended, as a step in the right direction. Supposing the amalgamation now proposed *un fait accompli*, the United Company will equal, if not surpass, in importance the Paris Gas Co. Now, the latter company make their own retorts and fire-bricks, distil their tar, manufacture sulphate of ammonia and artificial fuel, and do other things that add to the profits which would be made by the supply of gas alone. We are inclined to think the "United Company" might follow the example of the Paris Company with advantage. Retorts and fire-bricks could not be profitably manufactured at Beckton; but residuals, we fancy, might be worked up there with as much success as at Paris.—*London Jour. of Gas-Lighting.*

Chemical and Scientific Repertory.

SEA AIR AND MOUNTAIN AIR.—The difference between the action of sea air and that of mountain air on the human system has been recently explained by Professor Beneke, of Marburgh, whose experiments show that bodies part with their heat a great deal more rapidly on the sea-shore than among the mountains. Near the ocean the processes of change in the body are accelerated; and sea air is beneficial for persons who are overworked, but whose digestive organs are good. A mountain atmosphere, on the other hand, renders the bodily movements easier by reason of the diminished pressure, and increases the activity of respiration. Professor Beneke thinks that irritable, nervous persons will find themselves better in mountainous districts.

A NEW CEMENT.—A French chemist is said to have

ucceeded i n preparing a mineral compound, which is said to be superior to hydraulic lime for uniting stone and resisting the action of water. It becomes as hard as stone, is unchangeable by the air, and is proof against the action of acids. It is made by mixing together 19 lbs. sulphur and 12 lbs. pulverized stoneware and glass; this mixture is exposed to a gentle heat, which melts the sulphur, and then the mass is stirred until it becomes thoroughly homogeneous, when it is run into molds and allowed to cool. It melts at about 248° Fah., and may be reemployed without loss of any of its qualities, whenever it is desirable to change the form of an apparatus, by melting at a gentle heat, and operating as with asphalte. At 230° Fah. it becomes as hard as stone, and preserves its solidity in boiling water.

M. Lecocq de Boisbaudran has announced the discovery, by means of the spectroscope, of a new chemical element, which he calls "gallium," and which he affirms to allied to zinc. The spectroscope character of gallium is two violet lines, one corresponding to wave length 417, and the other to 404, but fainter. A commission of the French Academy has been appointed to report on the discovery. Gallium is said to be found in a special blende from Pierrefite mining works, in the Argeles Valley.

THE DISCOVERY OF PROTOSULPHIDE OF CARBON.—It is generally well known that, chemically, oxygen and sulphur greatly resemble each other. The sulphide of carbon, however, analogous in properties and composition to carbonic acid, has hitherto been considered the sole sulphuretted compound of carbon, there being nothing recognized corresponding to carbonic oxide to the sulphur series. M. Sidot has recently made the important discovery of protosulphide of carbon, which compound he obtains by subjecting bisulphide of carbon to sunlight, when the liquid undergoes a profound decomposition. Half of the sulphur separates to be dissolved in the bisulphide not yet altered, and at the same time a black powder is precipitated, which is the protosulphide sought for. This, washed and purified, is destitute of taste or odor, and is absolutely insoluble in neutral solvents. Acids act upon it, giving rise to more or less complex products.

The Electric Light has recently been applied for lighting the mills belonging to Messrs. Heilmann, Ducommun & Steinlein, in Mulhausen. In a separate room four magneto-electric machines are placed, which feed four suitably-located lamps constructed on the Serrin principle. The diminsions of the room so lighted are 60 metres (=196.8 feet) by 30 metres (=98.4 feet). Each lamp gives a light equal to about one hundred Carcel lamps. Each magneto-electric machine requires about 50 Kilogrammetre (360.8 foot-pound) motive power. The cost of the lamps, exclusive of the maintainance of the motive power, averages about 10d. per hour. The mageto-electric machines have each cost 1,500 francs (=£60), the whole arrangement amounting to 8,000 francs, or £320—*Electrica News.*

American Patents.

Patents issued for week ending Nov. 23, 1875.

	Class.	Number
Pipe Trap—T. Hudson, Brooklyn, N. Y.; filed Feb. 7, 1874	167	170,268

Patents issued for week ending Nov. 30, 1875.

Scrubber and Condenser combined, for Illuminating Gas—T. C. Hopper, Phil., Pa.; filed November 8, 1875	66	170,475
Pipe Joint—B. Jennings, California; filed April 11, 1875	100	170,476
Coupling Sections of Pipes or Tubing—Flagler & Brown, Boston; filed August 25, 1875	163	170,473
Supply and Connection Water Trap—J. H. Morrel (re-issue of No. 168,405); filed Oct. 5, 1875	167	6,774

Patents issued for week ending Dec. 7, 1875.

Automatic Lighter for Gas Burners—Stockwell & Weiss, Brooklyn, N. Y., filed October 29, 1875	90	170,913
Mattress for forming Embankments—Eads & Andrews, St. Louis; filed August 19, 1875	82	170,832
Illuminating Gas Apparatus—P. L. Allaire, Paris, France; filed Aug. 11, 1875	66	170,799
Gas Generating Apparatus—C. L. Vasquez, Philadelphia, Pa.; filed April 18, 1875	27	170,788
Gas Mixing Machine—L. Lanszweert, California; filed June 18, 1874	66	170,677
Fire-Place Heater—J. N. Atkinson, Pittsburgh. Pa.: filed November 1, 1875	154	170,801
Ventilating Louver—G. Hayes, New York; filed June 23, 1875	30	170,852
Waste Valve and Overflow for Baths and Basins—W. S. Carr, N. Y.; filed October 21, 1875	8	170,709
Water Meter—F. Phillippi, St. Louis Mo.; filed May 1, 1875	167	170,895

PRICES OF FOREIGN AND DOMESTIC GAS COALS.

[Reported Expressly for this Journal.]

DECEMBER 2, 1875.

DELIVERED IN NEW YORK.

English Cannel.			
Ince Hall	$17 00	@	18 00
Kirkless Hall	16 50	@	17 00
English Caking Coals.			
Newcastle Gas	$5 75	@	00 00
Liverpool caking	11 50	@	12 00
British Province Coals.			
Pictou			2 25
Block House—At Mines, $1.87, Gold			0 00
Caledonia—At Mines, $1.75, Gold			0 00
Little Glace Bay—At Mines, $1.75, Gold			2 00
Lingan—At Mines, $1.75, Gold			0 00
Sydney—Old Mine			3 00
" Reserve, $1.75, GoldMine			2 25
" International			— —

Duty, 75 cents per ton, gold. Freight to New York $2 25 (urrency. Cost of above coals delivered in New York, $5 25 @ $6 00½, currency.)

Pennsylvania Coals.			
Penn Gas Coal—At Amooy	$6 10	@	0 00
Westmoreland—At Amboy	6 10	@	0 00
(In New York both the above coals $6 50)			
Shafton	6 50	@	0 00
Youghiogheny	6 50	@	0 00
Waverly	6 50	@	0 00
West Virginia Coals.			
MurphyRun	$6 50	@	0 00
Despard	6 50	@	0 00
West Fairmont	6 50	@	0 00
American Gas Coal	7 40	@	0 00
Fairmont	6 50	@	0 00
Newburgh Orrel	6 50	@	0 00
Pinnickinick	6 50	@	0 00
Cloverhill of Virginia	6 00	@	6 50
McKenzie Compound Mixture			— —
American Cannel Coals.			
Peytona of West Virginia	$12 50	@	00 00
Darlington of Pennsylvania			— —
Cannelton Cannel			11 00
Red Bank—at Philadelphia			6 50
" —at South Amboy			7 25
Asphalts.			
Albertite of New Brunswick	$— 00	@	— 00
Ritchie Mineral of West Virginia	18 00	at Balt'e.	
Trinidad Bitumen	— —	@	14 05

The Penn Gas Coal Company have contracted with the PittsburghGas-Light Co. for their entire supply for th ensuing year from their Youghiogheny mines.

WREN'S GAS WORKS.

W. C. WREN,

Corner of Jay and Water Streets,

BROOKLYN, N. Y.

HAVING GRANTED THE USE OF ONE OF my Patents to the Gas-Light Company of America, and settled my claims against them, I inform the profession that I continue to erect the Works known as

Wren's Gas Works,

and sell Licenses to use my Patents for making Gas from Petroleum.

Gentlemen of the profession:—As your consumers demand a better light, and as that demand has been in many cases sought in vain to be met by using different abortive imitations of my various processes, would it not be well to make success sure by trying the plan of the inventor.

You can enrich your Coal Gas to any desired standard, by using my process, in the simplest manner, and much cheaper than by *any other* method. Address as above.

Advertisers Index.

☞ In looking for advertisements, see figures 1 to 12, within brackets, at head of advertisement pages.

GAS BURNERS, APPARATUS, ETC.

American Meter Co.—West 22nd st., N. Y., Arch and 22d st., Phil., 548 Washington st., Boston 11
Cast Iron Gas and Water Pipe—S. Decatur Smith, York and Moyer streets, Phila., Pa 8
Cast Iron Gas and Water Pipes—R. D. Wood & Co., Philadelphia Pa 10
Cast Iron Gas and Water Pipe—Jno. McNeal & Sons, Burlington, N. J 8
Franklin Foundry and Pipe Works—Jas. Marshall & Co., 23 Nineteenth street, Pittsburgh, Pa 2
Gas Valves (Chapman) 75 and 77 Kilby st., Boston, Mass 3
Gas-Burners—C. Gefrorer, 248 North 9th st., Phila., Pa 9
Gas Purification—St. John and Cartwright 5
Gas Meters, etc.—Harris, Griffin & Co., 12th and Brown streets, Phila., Pa 10
Gas Meters, etc.—Wm. W. Goodwin & Company, 1012 Filbert street, Phila, Pa 12
Gas Meter Manufacturers—Harris & Bro., 1117 Cherry st., Philadelphia, Pa 1
Gas Fixtures, Etc.—Mitchell, Vance & Co., 597 Broadway 7
Gasholders, Etc.—Delly & Fowler, 39 Laurel st., Phila., Pa 4
Gas Screen—James P. Mahon, Boston, Mass 5
Lime Hurdles.—Manhattan Lime Hurdle Co., Geo. W. Day, Treas., No. 3 Railroad Square, Haverhill, Mass 2
Lava Tips and Scotch Tips—Charles H. Meyer & Co., 227 Chestnut street, Phil. Pa 8
National Tube Works Co., 78 William St., N. Y 7
Patent Conically Slotted Wood Trays—John L. Cheesman, 147 and 149 Avenue C., N. Y 4
Patent Gas Exhauster—Smith & Sayre, 95 Liberty sttreet 4
Pelouze & Audouin Condenser—Jas. R. Smedberg, Sole Agent for U. S. San Francisco, Cal.; Henry Cartwright, 2107 Green street, Phil. Pa 1
Petroleum Gas—J. D. Patton, Treverton, Pa 4
Patent Gas Exhauster—S. S. Townsend, Agt., 31 Liberty street, N. Y 3

GAS COALS

Cannelton Coal Co. of West Virginia—J. Tatnall Lea, 325 Chestnut street, Phila, Pa 3
Despard Coal Co.—Parmelee & Bros., Agents, 32 Pine st., New York 7
Gas Coals—Perkins & Job, 27 South st., N. Y 7
New York and Cleveland Gas Coal Company—384 Penn Avenue, Pittsburgh, Pa 6
Penn Gas Coal Co.—11 Merchants' Exchange, Phil. and 90 Wall street, N. Y 6
Peytona Cannel Coal—S. E. Low, 58 Broadway, N. Y 5
The Newburg Orrel Coal Co.—Chas. W. Hays, Agent in New York, Trinity Building, 111 B'way, Room 7 6
Tyrconnell Gas Coal—52 S. Gay Street, Baltimore, Md 6
Westmoreland Coal Co.—230 South 3rd Street, Phil. Pa 7
Youghegheny Coal—Perkins & Job, 27 South St. N. Y 7

FOUNDRIES.

Atlantic Dock Iron Works—John P. Kennedy, Office 98 Liberty street, N. Y., P. O. Box 2348 12
Cast-Iron Pipes and Fittings—B. S. Benson, 52 East Monument street, Baltimore, Md 5
Continental Works—T. F. Rowland, Greenpoint 4
Camden Iron Works, Camden, N. J.—Jesse W. Starr & Son.
Gloucester Iron Works—J. P. Michellon, Sec., 6 North 7th street, Phila., Pa 5
Mill Street Foundry.—Geo. Stacey & Co., Cincinnati, O 10
National Foundry and Pipe Works—Wm. Smith, Carroll, Pike, Smallman & Wilkins streets, Pittsburg, Pa 2
Oregon Iron Foundry.—Herring & Floyd, 740 Greenwich street, N. Y 10
Pascal Iron Works—Morris, Taskar & Co., Philadelphia 12
Providence Steam and Gas Pipe Co., Providence, R. I.—H. A. Branch, Agent 3

WATER METERS, PUMPS, ETC.

Cast Iron Pipes for Water and Gas—Riley A. Brick, 112 Leonard street, N. Y 10
Valves for Water, Steam and Gas—Ludlow Valve Man'g Co., 940River street, Troy, N. Y 16

CLAY RETORT WORKS.

B. Kreischer & Son, Clay Retorts, etc., 58 Goerck st., N. Y. 8
Cheltenham Fire Brick and Clay Retort Works—Evens & Howard, 916 Market street, St. Louis, Mo 8
Manhattan Clay Retort Works, 15th st., near Av. C, N. Y. 8
Philadelphia Fire Brick Works, Vine and 23d sts., Phila 8

LAMPS, STOVES, PETROLEUM, ETC.

Lamps—M. B. Dyott, 114 South 2nd Street, Phil. Pa 1
Patent Lamp Post—J. W. Graham, Chillicothe, Ohio, or A. M. Callender, office of this Journal 9

MISCELLANEOUS.

Analysis and Testing of Gas Coals—Prof. Henry Wurtz, 12 Hudson Torrace, Hoboken, N. J 10
Architect and General Gas Engineer—William Farmer, 111 Broadway Room 96, N. Y 6
Brass Cocks, Plumbers' Materials, etc., etc.—McNab & Harlin Manufacturing Co., 56 John st., N. Y 7
Cements—S. L. Merchant & Company, 76 South st., N. Y. 6
Contractors for Gas Works, Etc.—Murray & Baker, Fort Wayne, Ind 2
Fodell's System of Bookeeping—A. M. Callender & Co., 42 Pine st., New York 1
Gas Engineer—B. E. Chollar, 914 Olive St., St. Louis, Mo 6
Gas-Light Company of America, 63 and 64 Drexel Building, New York 2
Kidd's Gas Consumers Guide—A. M. Callender & Co., 42 Pine Street, N. Y 6
Massachusetts Institute of Technology—Samuel Kneeland Boston, Mass 9
National Coal Gas Company—H. P. Allen, 4 Warren street New York 6
School of Mines, Columbia College, East 49th st 9
Screening Shovels—Herring & Floyd, 740 Greenwich st., New York 7
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MANUFACTURERS OF

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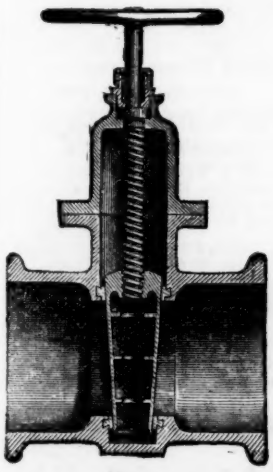

These Valves have been in use for several years, and are pronounced by all who have used them to be

The Best Gas Valves Ever Made.

They afford a direct passage the full size of the pipe. The seats are made of an alloy similar to BABBITT metal, specially prepared for the purpose, and superior to all other metals used for the seats of Gas Valves. It does not corrode under any circumstances to which it is exposed.

There is NO LIABILITY OF COHESION between the Gate and Seat, and the Valves can be relied upon to SHUT TIGHT and OPEN EASILY at all times—an important desideratum when used for street mains, in cases of fire.

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LAWRENCE GAS-LIGHT COMPANY, LAWRENCE, MASS.
PEOPLES GAS-LIGHT COMPANY, BROOKLYN, N. Y.
CITIZENS GAS-LIGHT COMPANY, BROOKLYN, N. Y.
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CHARLESTOWN GAS-LIGHT CO., CHARLESTOWN, MASS.
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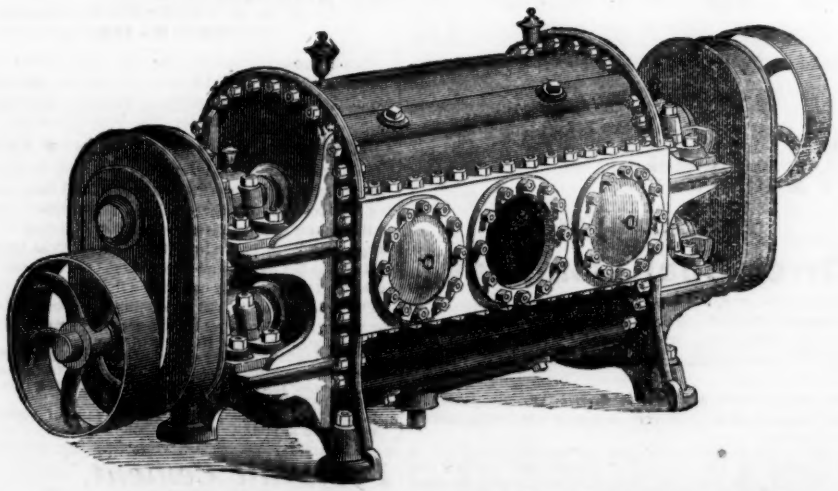

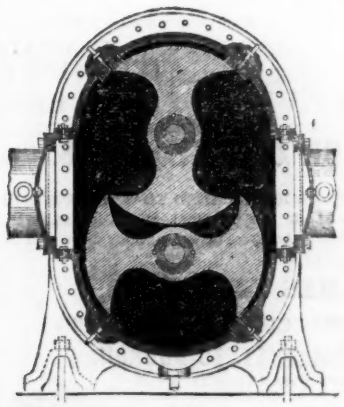

P. H. & F. M. ROOTS, PATENTEES AND MANUFACTURERS, CONNERSVILLE, IND.
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The following are some of the advantages we claim for this Exhauster over all others:

FIRST.—It is simpler in its mechanical construction than any other Exhauster in use.

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THIRD.—Every part of the machine requiring care or attention, as the journals, gearing, etc., is external, easily observed and attended to. All changes, adjustments, and repairs are made from the outside. The journal bearings, if necessary, can be renewed in a few minutes.

FOURTH.—The internal operating parts are practically gas-tight, but are not in actual contact, hence there is no internal friction or wear. The machine is therefore operated with less power than any other.

FIFTH.—They are built in the most complete and substantial manner, with steel shafts and improved journal bearings, and their durability is almost without limit.

We build them of any required capacity, large or small, adapted to any kind of works or place.

Send for Illustrated Catalogue, giving all particulars as to capacity, speed, power required, dimensions, and price of each size and references to parties using them.

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COAL, CAREFULLY SCREENED,

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Their Property is located in the Youghiogheny Coal Basin, near Irwin's and Penn Station, on the Pennsylvania Railroad, and on the Youghiogheny River.

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OF WEST VIRGINIA.

Offer for sale the following Coals, from their Colliery at CANNELTON, Kanawha County, West Virginia, delivered at RICHMOND, Va.:

CANNELTON CANNEL,

cknowledged to be the most valuable ENRICHER produced in this country, a gross ton yielding 10,000 ubic feet of GAS of 64·54 CANDLE POWER; COKE 32 bushels, of good quality.

CANNELTON CAKING COAL.

Volatile Matter.	Coke.	Per cent. of Ash in Coal.	Per cent. of Ash in Coke.	Sulphur in Coke.	Sulphur in Ootl.	Sulphur in Volatile Matter.	Specif. Gravity. Coal.	Specif. Gravity. Gas.
35.1	64.9	2	6	.82	1.48	.66	1,289	.476

MAXIMUM YIELD, 5.06 cubic feet of Gas per pound of Coal—A yield of 4·78 cubic feet per lb.. —gave 16 14-100 Candle-Power.

COKE, of very fine quality—1453 pounds produced from one ton of coal.

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THE SUBSCRIBER IS PREPARED TO CONTRACT FOR the supply of all the principal SCOTCH CANNEL COALS. Prices and Analyses of the various Coals will be forwarded on application.

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CANNEL COAL MERCHANT,

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A CHRISTMAS PRESENT that will pay you to make. Expend one dollar and save hundreds.

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Orrel Coal Company,

Mines at Newburg, Preston County, W. Va.

Company's Office, No. 52 S. Gay Street, Baltimore, Md.

C. OLIVER O'DONNELL, Pres't. CHAS. MACKALL, Sec'y.

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SINCLAIR & AGNEW, Agents, Alexandria, Va.

This Company offer their very superior Gas Coal at lowest market prices.

It yields 10,996 cubic feet of gas to the ton of 2,240 lbs. of good illuminating power, and of remarkable purity; one bushel of lime purifying 6,792 cubic feet, with a large amount of coke of good quality.

It has been for many years very extensively used by various Gas Companies in the United States, and we beg to refer to the Manhattan, Metropolitan, and New York Gas Light Companies of New York; the Brooklyn and Citizen's Gas Light Companies of Brooklyn, N. Y.; the Baltimore Gas Light Company of Baltimore, Md., and the Providence Gas Light Company, Providence, R. I.

The best dry coals shipped, and the promptest attention given to orders. 294-1y

THE DESPARD COAL COMPANY

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DESPARD COAL

To Gas Light Companies throughout the country.

Agents, PARMELEE BROTHERS, No. 32 Pine street, N. Y.

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Mines in Harrison County, West Virginia.

Wharves Locust Point, Company's Office, 29 South street, } Baltimore.

Among the consumers of Despard Coal, we name: Manhattan Gas Light Company, New York; Metropolitan Gas Light Company, New York; Jersey City Gas Light Company, N. J.; Washington Gas Light Company; Portland Gas Light Company, Maine.

*** Reference to them is requested. 304-1y

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Of Pittsburgh, Pa.

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YOUGHIOGHENY GAS COAL.

This Company is prepared to furnish any amount of their justly celebrated, and acknowledged superior GAS COAL, to any point reached by railroad or navigation, on most favorable terms.

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W. H. WATERBURY & CO., General Sales Agents,
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This Company is the owner of the GWYNNE-HARRIS, or AMERICAN HYDROCARBON process, for making Gas for Lighting or Heating purposes, by the perfect decomposition of superheated steam, under what is known as the

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This process has been fully tested nearly 50,000,000 cubic feet of Gas having been made under it, and fully demonstrating the fact that it is the greatest improvement ever made in the manufacture of Gas, either for Lighting or Heating purposes. With half a ton of Anthracite Coal 150,000 cubic feet of Gas per day is made from three benches, and the labor is so small that one man can attend three or four benches.

The process can be put into either Coal or Oil Gas Works (or where both Coal and Oil are used) at small cost, without any interruption to the working of other benches. The Citizens Gas-Light Company of Brooklyn, after using it for more than seven months, have found it not only far better, but actually *cheaper* than atmospheric air in making Gas, with the use of "petroleum and its products."

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Portland Cement,
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NUMBERS 1 AND 2.

From best London Manufacturers.

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ENAMELED GAS AND WATER PIPE,

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Lap-welded Steam and Gas Pipe,
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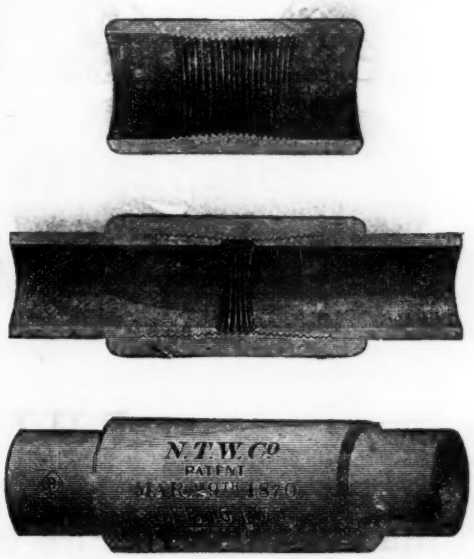

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Offer for Sale the

YOUGHIOGHENY COAL

DOUBLE SCREENED,

from their Colliery at Smith's Mills, on the Youghiogheny River, thirty-seven and a half miles southerly of Pittsburgh. This Coal has the preference in Pittsburgh over all other YOUGHIOGHENY COAL for GAS PURPOSES.

The facilities of the WAVERLY COMPANY are unsurpassed by those of any other Company on the Youghiogheny.

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CHARTERED 1854.

MINES situated on the **Pennsylvania** and the **Connellsville Railroads** in **Westmoreland County, Pa.**

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Since the commencement of operations by this Company its well known

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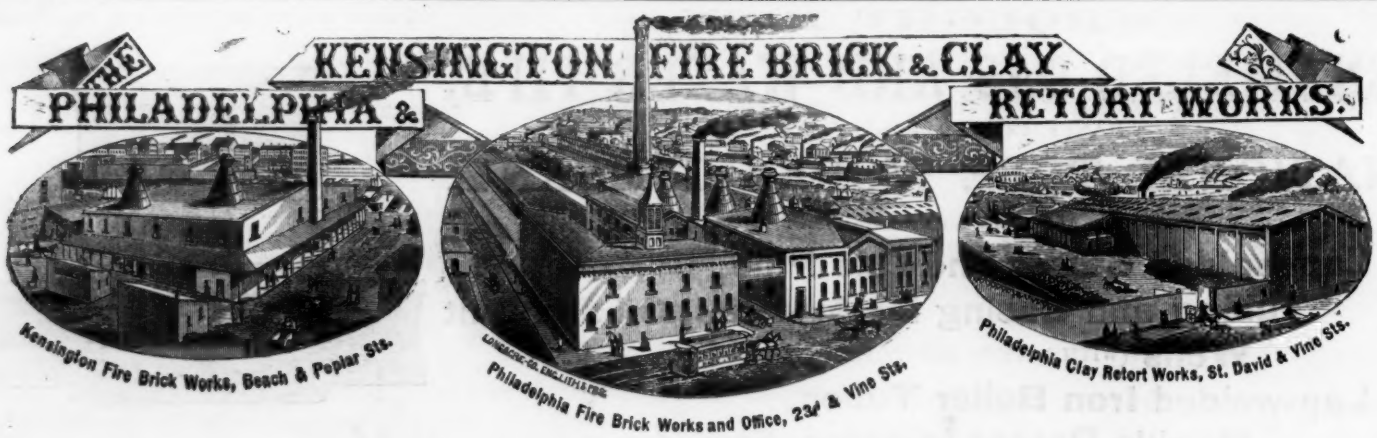
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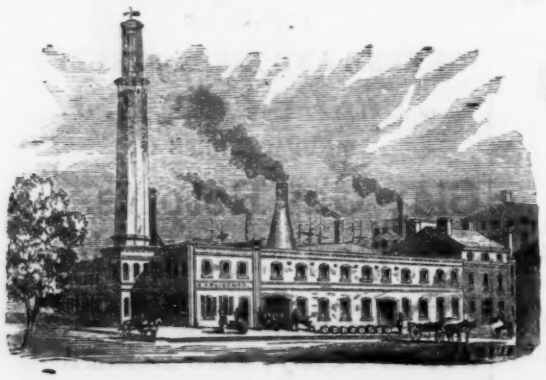

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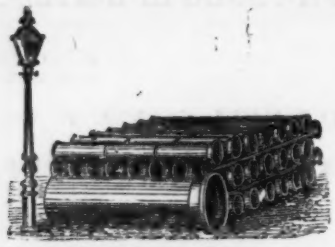

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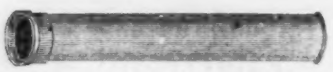

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Several Thousand 2, 3, 4, 6 and 8 Inch Cast Iron *Gas and Water Pipes* on hand, for immediate delivery.

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(Successor to MAURER & WEBER.)
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ALL ORDERS DELIVERED FREE TO NEW YORK.
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Our experience in the manufacture of Pipe for a great many years, has enabled us in rebuilding to practically apply Machinery and Fixtures of the very best character, to insure *good work*.

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S. F. DEWEY, V. Pres. } OFFICE OF {CHAS. F. DEAN, Sec.

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Nos. 63 and 64 Drexel Building,

P. O. Box, 5131. NEW YORK.

THE GAS-LIGHT COMPANY OF AMERICA, owners of the Patent Processes for making ILLUMINATING GAS from PETROLEUM and its products, known as the

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AND
Wren and Barker Patents,

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Gas of unexceptional quality, of high illuminating power is made at many of these works by these processes, at a cost of from 40 per cent. to 60 per cent. less than an ordinary qualito of illuminating gas can be made by any other methods in use. Gas Companies generally may easily, and at small outlay for making the necessary changes in manufacturing apparatus, double their net earnings, and supply a much better light their patrons, at greatly reduced prices.

The Company respectfully refer to Companies using these processes in this city, Reading, Penn., Chicago and elsewhere, and especially to the Mutual Gas-Light Company of Detroit, Mich., whose works more nearly conform in all details of construction to the original plans of the inventors, than those of other Companies.

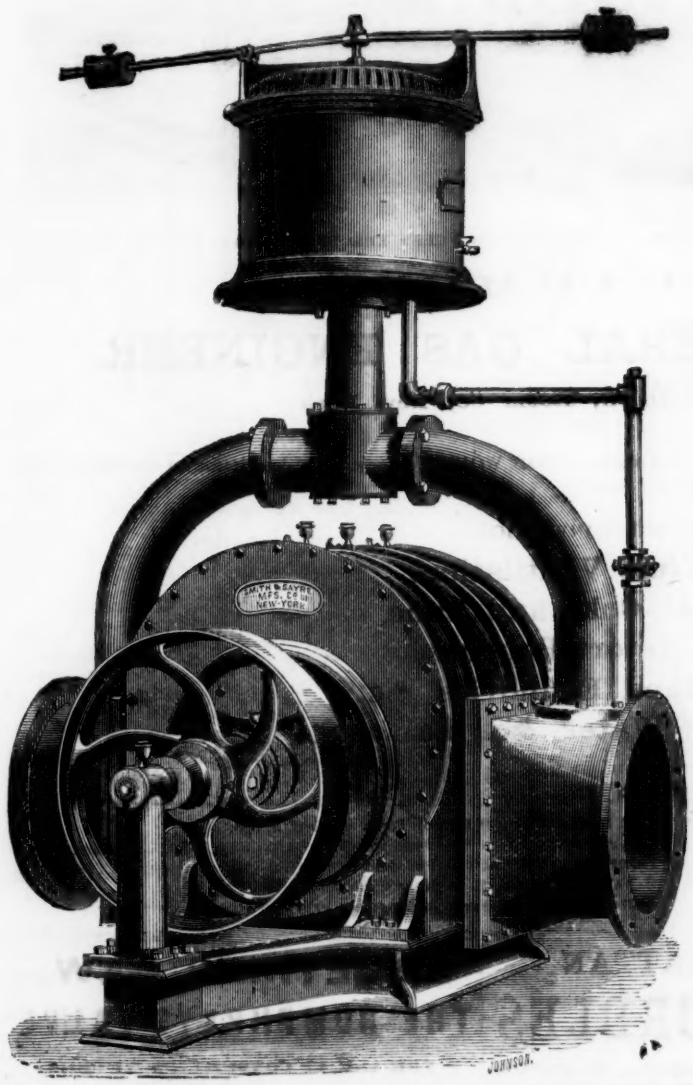
For Correspondence, etc., address to office as above.

CHARLES F. DEAN, Secretary

SMITH & SAYRE MANUFACTURING COMPANY.

The Mackenzie Patent Gas Exhauster

And Patent Compensator.



They are made to pass from 4,000 to 150,000 cubic feet of gas per hour; will increase the production and illuminating power of the gas, and add very much to the durability of the retorts, either clay or iron. The Compensator obviates entirely the necessity of water-jo ints, is compact, durable, cleanly, not liable to get out of order, self-acting, quiet, and certain in its operation.

We are also sole proprietors and manufacturers of the

MACKENZIE PATENT BLOWER, PATENT CUPOLA AND SMELTING FURNACE.

The Blower is a Force Blast machine, durably built, and can be driven with one-third the power required to drive the ordinary fan

The Cupolas are manufactured in sizes to melt from 1 to 20 tons per hour, will save one quarter of the time required by the old style Cupola and 33 per cent fuel. Address

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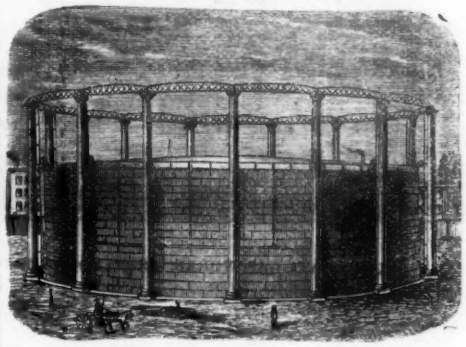

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OF ANY MAGNITUDE,

Condensers, Scrubbers, Purifiers, Retorts, Hydraulic Mains and all other articles connected with the Manufacture and Distribution of Gas, furnished with despatch. Plans and Specifications prepared, and Proposals given for the necessary Plans for Lighting Cities, Towns, Mansions, and Manufactories.

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Office in Philadelphia No. 435 Chestnut St., where a member of the Firm can be seen between 12 m. and 2 p. m. daily.

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For Retort and other houses Retorts and all castings required for setting them in the latest and most improved model. WASHERS, CONDENSERS, SCRUBBERS and EXHAUSTERS for relieving the Retorts from pressure. PURIFIERS, varying from 2,000 to 2,000,000 cubic feet daily purifying capacity.

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All the Smith and Sheet Iron work required in and abou Gas Works. 226-tf

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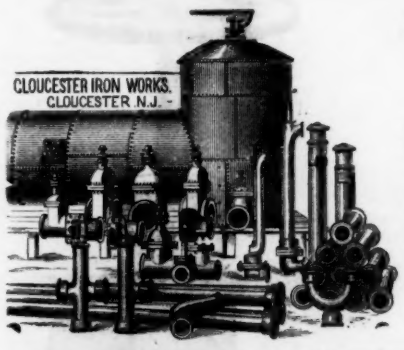

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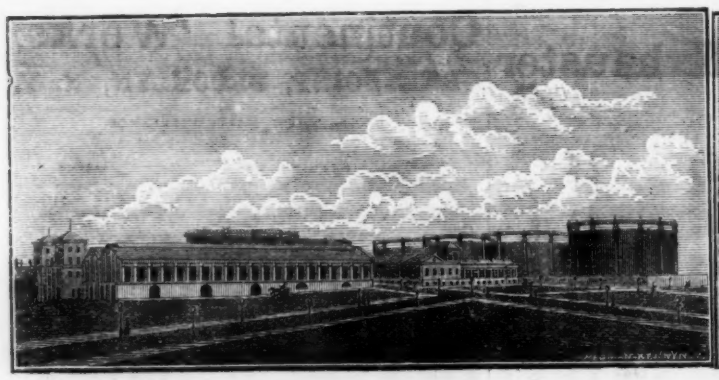

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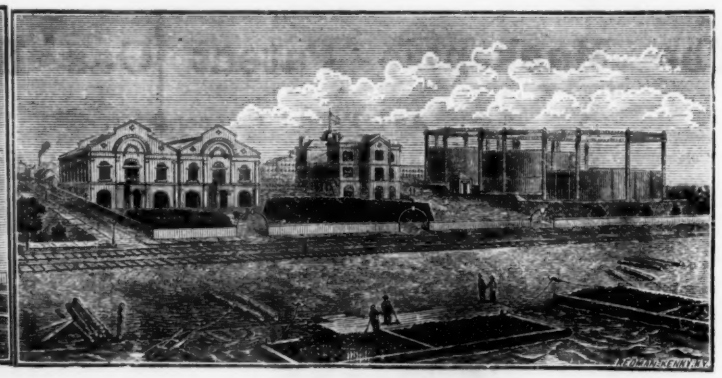

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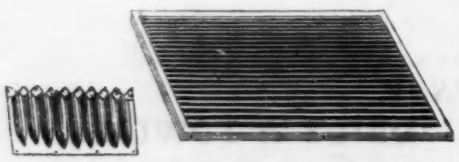

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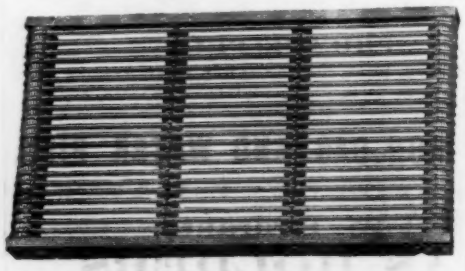

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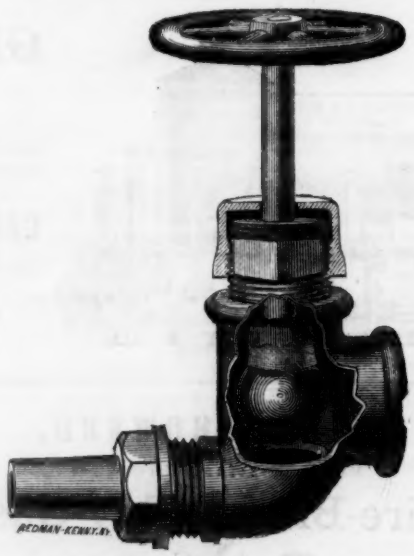

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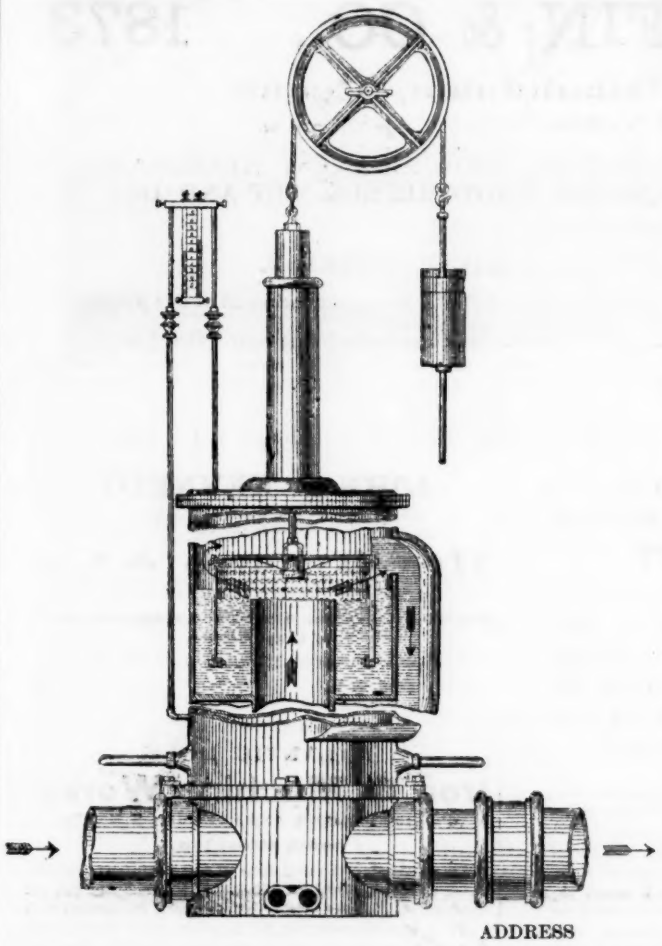

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EXHAUSTERS.—Exhausters and Compensators, By-Passes to pass from 4,000 to 150,000 Cubic feet of Gas per hour, with Engines, Governors, Pressure and Vacuum Guages.

SCRUBBERS.—Single or Multitubular Scrubbers, with Self-Acting Pumps for Ammonia Water.

WASHERS.—Cataract and Single and Multitubular Spray Washers.

CONDENSERS.—Single and Multitubular Air and Water Condensers.

PURIFIERS.—For Purifying from 1,000 to 2,000,000 cubic feet capacity daily, with either wet or dry Lime, or Oxide of Iron, and with either Ash Rivetted or Wrought or Cast Iron Lime Sieves.

CARRIAGES.—Movable Lifting Carriages for Purifiers, arranged either for Floor or Overhead use.

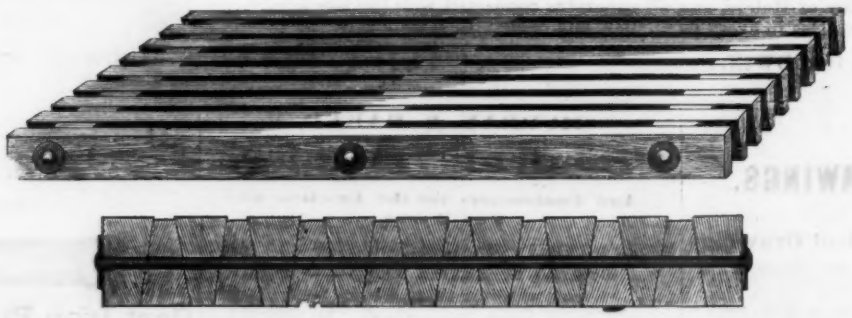
METERS.—Square and Round Meters of any capacity.

GAS HOLDERS.—Single Lift and Telescopic Gasholders, with Cast or Wrought Iron Suspension Frames.

GAS GOVERNORS.—Station Governors, with Regulating and Indicating Columns for Inlet and Outlet Pipes, also Dry Governors with Flexible Diaphragms for Underground Pipes.

STOP VALVES.—Double Faced Stop Valves for Gas or Water, from three inches to forty-eight inches diameter. These Valves are proved on both sides, with a heavy Water Pressure, Flange and Bell Pipes, Fittings and Drips of all descriptions. Steam Boilers and Hot Water Apparatus for Heating Building, and Gas Holder Tanks. Lamp Posts and Lanterns.

P. Munzinger's Patent Ash Lime Trays.



In use at the following Gas-Light Companies:

Pittsburg Gas Company, Pa.
Peoples Gas Company, Baltimore.
Lowell Gas-Light Company, Mass.
Lynn Gas-Light Company, Mass.
Albany Gas-Light Company, N. Y.
Schenectady Gas Light Company, N. Y.
Utica Gas-Light Company, N. Y.
Jersey City Gas Company, N. J.
St. Paul Gas-Light Company, Minn.
Cumberland Gas-Light Company, Md.
Hartford City Gas-Light Company, Conn.
Richmond Gas Company, Va.
McKeesport Gas Company, Pa.
Middletown Gas Company, Pa.
East Newark Gas-Light Company, N. J.
Binghampton Gas Company, N. J.
Zanesville Gas Company, Ohio.

New Orleans Gas Company, La.
Salem Gas-Light Company, Mass.
New Britain Gas-Light Company, Conn.
Rahway Gas-Light Company, N. J.
Trenton Gas-Light Company, N. J.
Elmira Gas Company, New York.
Erie Gas Company, Pa.
Columbus Gas-Light Company, Ohio,
Westchester Gas-Light Company, N. Y.
Santa Cruz Gas Company, Cal.
Lawrence Gas-Light Company, Kansas.
Salem Gas Company, N. J.
Indiana Gas-Light Company, Pa.
Peoria Gas Company, Ill.
Montclair Gas Company, N. J.
Williamsport Gas Company, Pa.
Wooster Gas Light Company, Ohio.

Augusta Gas-Light Company, Ga.
Huntsville Gas Company, Ga.
Chattanooga Gas Company Tenn.
Murfreesboro Gas Company, Tenn.
Hagerstown Gas-Light Company, Md.
Hanover Gas Company, Pa.
Easton Gas Company, Pa.
Uniontown Gas-Light Company, Pa.
Coatesville Gas-Light Company, Pa.
Houston, Gas Company, Texas.
Wilkesbarre Gas Company, La.
Middletown Gas Company, New York.
Washington Gas-Light Company, Pa.
Princeton Gas-Light Company, N. J.
Newark Gas Company, Ohio.
Pontiac Gas-Light Company, Mich.
And numerous other Companies.

JAN 24 1876